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Highway Safety Literature

An Announcement
of Recent Acquisitions. . .



U.S. International Transportation Exposition
Dulles International Airport
Washington, D.C.
May 27-June 4, 1972

HSL No. 71-31
December 17, 1971



THIS ISSUE CONTAINS:

HS-010 233 - HS-010 312
HS-800 529, 534, 546-548,
HS-800 552, 559, 560, 573, & 589

U.S. Department of Transportation / National Highway Traffic Safety Administration

HSL No. 71-31 December 17, 1971 HS-010 233 - HS-010 312, HS-800 529, 534, 546-548, HS-800 552, 559, 560, 573, & 589

71-31

HIGHWAY SAFETY LITERATURE AN ANNOUNCEMENT OF RECENT ACQUISITIONS

Published Bi-Weekly (26 times a year) by the National Highway Traffic Safety Administration
Research Institute, Office of Accident Investigation and Data Analysis
Washington, D.C. 20590

INTRODUCTION

Publications announced in *Highway Safety Literature* include the most recent additions to the collection of the NHTSA Scientific & Technical Information Service. Subject areas covered include all phases of highway, motor vehicle, and traffic safety, especially those encompassed by the National Traffic and Motor Vehicle Safety Act of 1966 and the Highway Safety Act of 1966.

Individual issues of *HSL* are numbered according to the year and the issue number within that year; thus, 71 designates the year and 1, 2, 3, etc. the individual issues. To aid the user in locating citations by the HS-number, the cover bears the inclusive entry number for each issue.

Entries in *HSL* are arranged according to the NHTSA Subject Category List shown in the Table of Contents. The list is a two-level arrangement consisting of five major subject fields subdivided into 59 subject groups. Documents related directly to the National Highway Traffic Safety Administration

(NHTSA) are announced in a separate section headed NHTSA DOCUMENTS and are numbered in five distinct series: NHTSA Accident Investigation Reports (HS-600 000 series), NHTSA Compliance Test Reports (HS-610 000 series), NHTSA Contractors Reports (HS-800 000 series), NHTSA Staff Speeches, Papers, etc. (HS-810 000 series), and NHTSA Imprints (HS-820 000 series). For NHTSA DOCUMENTS in series HS-600 000 and HS-610 000, individual full case reports are available for inspection at the National Highway Traffic Safety Administration. HS-800 000 series and HS-800 000 series are available for purchase from NTIS or GPO (see page ii). Although announced together in a separate section, these documents are also assigned specific subject categories for machine retrieval.

A document which contains a number of separate articles is announced as a complete volume in the subject category most applicable to it as a whole. Entries for the individual articles appear in their most specific subject category.

SAMPLE ENTRIES

Subject Category Array

NHSB Accession no..... HS-800 218 Fld. 5/21; 5/9
Title of document..... AN INVESTIGATION OF USED CAR SAFETY STANDARDS-SAFETY INDEX: FINAL REPORT. VOL. 6 - APPENDICES G-L
Personal author(s)..... by E. N. Wells; J. P. Fitzmaurice; C. E. Guilleams; S. R. Kalin; P. D. Williams
Corporate author..... Operations Research, Inc.
Collation.....
Publication date..... 1969 150p
Contract FH-11-6921
Report no. ORI-TR-553-Vol-6; PB-190 523
Abstract..... Appendices G-L to this study of used car safety standards include: indenture model diagrams for classes I-IV motor trucks; degradation, wear, and failure data for motor truck classes I-IV; and safety index tables for classes I-IV motor trucks.

Search terms; Wear; Trucks, Failures; Used cars; Inspection standards

HS-004 497 Fld. 5/19

AUTO THEFT-THE PROBLEM AND THE CHALLENGE

by Thomas A. Williams, Sr.

Journal citation . . . Published in *FBI Law Enforcement Bulletin* v37 n12 p15-7 (Dec 1968)

Gives figures on the extent of the auto theft problem and comments on antitheft devices available now or in the planning stage.

Search terms: Theft; Theft protection; Stolen cars

AVAILABILITY: NTIS

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NOTE: () Numbers in parentheses following certain subject groups indicate the Highway Safety Program Standards (No. 1, and up) and/or Federal Motor Vehicle Safety Standards (No. 101 and up) which may apply to these groups.

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NOTE: Material published in Highway Safety Literature (HSL) is intended for the information and assistance of the motor vehicle and highway safety community. While brand names, equipment model names and identification, and companies may be mentioned from time to time, this data is included as an information service. Inclusion of this information in the HSL should not, under any circumstances, be construed as an endorsement or an approval of any particular product, course, or equipment by the U. S. Department of Transportation, National Highway Traffic Safety Administration.

Harry A. Feinberg
Managing Editor

**AVAILABILITY OF DOCUMENTS
AND
INSTRUCTIONS FOR ORDERING**

Articles and reports whose citations and abstracts appear in HSL are acquired from many sources, such as periodicals, journals, NHTSA Contractors and NHTSA staff speeches, and other reports. Those reports other than NHTSA Contractors' reports and NHTSA generated reports and speeches (see introduction) are assigned a lower consecutive accession (HS-) number.

Department of Transportation personnel may borrow copies of publications announced in HSL from the NHTSA Technical Reference Division. Non-DOT Personnel, in the Washington, D.C. area, may borrow copies of publications for a 24-hour period only. Telephone (202) 426-2768. Government personnel in the Washington, D.C. area, use government ID phone 118-62768.

The names of the journals cited in HSL appear in italic type preceded by the words "Published in." The journal containing the article cited may be borrowed from most research and public libraries. Non-DOT personnel outside the Washington area should contact their company or agency libraries for assistance.

NHTSA Contractors' reports and other reports can usually be obtained as indicated under AVAILABILITY. However, there is no certainty that copies will be available for more than a limited period after a report is issued.

The more common availability sources are identified by symbols which are explained in the next column:

HTIS: National Technical Information Service, Springfield, Va. 22151. Order by accession number: HS, AD, or PB. Prepayment is required by NTIS coupon (GPO coupons are not acceptable), check or money order (made payable to the NTIS). PC (Paper copy; full size original or reduced facsimile) prices are \$3.00 up to 300 pages, \$6.00 for 301 to 600 pages, \$9.00 for 601 to 900 pages, and over 900 pages will be quoted on request. Surcharge is added for foreign orders. MF (microfiche approximately 4x6" negative sheet film; reader required) is \$0.95 per report.

GPO: Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402. Give corporate author, title, personal author, and report number. Prepayment is required by GPO coupon (NTIS coupons are not acceptable), check or money order (made payable to the Superintendent of Documents).

HRB: Highway Research Board, National Academy of Sciences, 2101 Constitution Ave., N. W., Washington, D. C. 20418.

NHTSA: National Highway Traffic Safety Administration, General Services Division, Washington, D.C. 20590 (Telephone (202) 426-0874), Give HS-No.

SAE: Society of Automotive Engineers, Dept. HSL, 2 Pennsylvania Plaza, New York, N.Y. 10001. Order by SAE report numbers. Prices given are list; discounts are available to SAE member and sometimes to libraries and U.S. Government Agencies. Prepayment is required; orders received without payment are subject to a \$1 handling charge.

IMPORTANT NOTICE

WHEN REQUESTING a document, to be absolutely sure you receive what you order, give the accession number (HS, PB, AD number) or report number (in cases such as an SAE document), title of report, and the personal or corporate author (whichever is cited). When requesting an HS-numbered document from NTIS, add DOT/ to the prefix HS-; example HS-800 000 should be ordered as DOT/HS-800 000.

1/0 ACCIDENTS**1/1 Emergency Services****HS-010 233 Fld. 1/1****HELICOPTER AMBULANCES:
AN EVALUATION OF THEIR
OPERATIONAL AND ECONOMIC
FEASIBILITY**

by Hale C. Bartlett

Published in *Traffic Digest and Review*
v19 n7 p1-7 (Jul 1971)

69 refs

The expected mortality rate among victims of serious accidents increases threefold for each 30 minutes elapsing between injury and definitive medical care. With its speed and flexibility, the helicopter is helping to attain the objective of minimizing time between injury and hospital treatment. Several experimental programs are described, and an evaluation of the operational and economic feasibility of two in particular is made: the Air Medical Evacuation System developed by Arizona State University, and the Ohio State University Medicopter Program.

Search terms: Helicopter ambulances;
Emergency medical services; First aid;
Accident survival time; Time factors;
Costs; Accident severity

1/2 Injuries**HS-010 234 Fld. 1/2****DECELERATION TRAUMA TO
THE HEART AND GREAT
VESSELS AFTER
ROAD-TRAFFIC ACCIDENTS**

by M. J. Goggin; F. D. Thompson; J. W. Jackson

Published in *British Medical Journal* v2
p767-9 (27 Jun 1970)

7 refs

Four young men involved in high-speed car crashes developed cardiovascular trauma. Two patients had aortic aneurysms, one rupture of the mitral valve, and one ventricular septal defect; successful surgical correction was undertaken in all. The importance of considering the possibility of cardiovascular trauma in these circumstances is emphasized, and X-ray films (repeated if necessary) should be taken even when there are no external signs of trauma.

Search terms: Aortic injuries;
Cardiovascular system; Cardiothoracic
injuries; Deceleration caused injuries;
Surgery; Heart injuries; Medical case
reports; Medical treatment

HS-010 235 Fld. 1/2**NECK INJURY TO WOMEN IN
AUTO ACCIDENTS**

by Charles H. Schutt; F. Curtis Dohan

Published in *Lawyers' Medical Journal*
v5 n4 p407-20 (Feb 1970)

24 refs

Reprinted from *Journal of American Medical Association*, 16 Dec 1968.

This article demonstrates the high rate of neck injuries incurred in auto accidents by women in metropolitan regions; it presents data on the accident, time lost from work, onset and duration of symptoms, and their relation to litigation. It reviews some recent work on the pathological characteristics and prevention of whiplash injury. Data do not support the opinion that prolonged symptoms are commonly due to litigation neurosis or malingering. Proper headrests prevent whiplash injuries and are required in automobiles made after December 31, 1968.

Search terms: Whiplash injuries; Neck
injuries; Disability evaluation;
Litigation; Accident caused neurosis;
Head restraints; Females; Cervical
spine; Time factors

HS-010 236 Fld. 1/2**WHIPLASH**

by Harold I. Magoun, Sr.

Published in *Health* p5-8 (Jan 1970)

The different causes, the symptoms, the diagnosis and treatment of whiplash injury are presented. Restraint system usage is suggested as the best means of preventing whiplash injuries.

Search terms: Whiplash injuries;
Diagnosis; Head restraints; Shoulder
harnesses; Medical treatment

HS-010 237 Fld. 1/2**THE NATURE OF SEAT BELT
INJURIES**

by James S. Williams; John R. Kirkpatrick

Published in *Journal of Trauma* v11 n3
p207-18 (Mar 1971)

53 refs

Presented at American Assoc. for the
Surgery of Trauma 28th annual
meeting, Montreal, 18-20 Oct 1968.

This study investigates the nature of safety belt injuries based on an analysis of cases which appear in the literature as well as some not previously reported. The injury pattern characteristics of the three types of restraint systems, the lap-type belt, the two-point diagonal or shoulder restraint, the three-point (shoulder-lap) belt are described. It is concluded that a combination shoulder and lap restraint system is most effective in preventing injury and mortality.

Search terms: Seat belt medical
factors; Three point restraint systems;
Abdominal injuries; Intestinal injuries;
Seat belt caused injuries; Spinal
injuries; Shoulder harness caused
injuries; Ruptures; Fractures; Medical
treatment; Diagnosis; Surgery; Injury
case reports

HS-010 238 Fld. 1/2

SEAT-BELT INJURIES

by Klaus D. Backwinkel

Published in *Lawyers' Medical Journal*
v5 n4 p397-405 (Feb 1970)

17 refs

This is an evaluation of current research into the effects of seat belts in automobile accidents, with a discussion of the mechanics and basic characteristics of seat belt injuries. It is concluded that seat belts save lives by reducing accident fatalities caused by ejection, but this primarily protective device is also responsible for distinctive injury patterns.

Search terms: Seat belt caused injuries; Abdominal injuries; Intestinal injuries; Spinal injuries; Pelvic injuries; Uterine injuries; Diagnosis; Medical treatment; Injury research; Ruptures; Stomach injuries; Deceleration

HS-010 239 Fld. 1/2; 1/1; 5/14

NEW CONCEPTS IN TRAUMATIC SURGERY

by Preston A. Wade

Published in *Proceedings of the Rudolf Virchow Medical Society in the City of New York* v22 p114-29 (1963)

Transportation of the injured and the problems in the hospital emergency rooms are reviewed and suggestions are made for improvement. The relationship of automobile design to injury patterns is discussed. Ejection, safety belts, impacts with the interior of the car, and door opening problems are described. Organizations interested in the trauma of accidents are briefly discussed. The article mentions surgery very briefly.

Search terms: Injury statistics; Safety design; Transportation of injured; Emergency medical services; Hospital emergency rooms; Accident hospitals; Injury severity; Door system failures;

Ejection; Secondary collisions; Automobile design; Occupant protection; Seat belts

HS-010 240 Fld. 1/2; 1/3; 3/1; 3/4

PSYCHIATRIC AND LEGAL ASPECTS OF AUTOMOBILE FATALITIES

by John R. Finch; James Patrick Smith, Jr.

Baylor Univ.

1970 150p

Discusses the automobile, injury and the death problem; the "accident" epidemic; the psychiatric approach to automobile fatality investigations; gives an epilogic summary to the Houston study; legal aspects of the drinking-driver phenomenon; and medical aspects of the drinking-driver phenomenon: the treatment approach.

Search terms: Accidents; Injuries; Fatalities; Accident causes; Injury causes; Fatality causes; Accident prevention; Drinking drivers; Legal factors; Forensic medicine; Medical factors; Epidemiology; Psychological factors; Medical treatment; Physicians and highway safety; Driver intoxication; Driver behavior; Accident research; Psychotherapy

HS-010 241 Fld. 1/2; 1/5

INJURY PATTERNS IN ROAD TRAFFIC ACCIDENTS

by Pars Slatis

Published in *Annales Chirurgiae et Gynaecologiae Fenniae*, v56 Supp 150 p5-39 (1967)

45 refs

Analysis was made of 5,291 accident cases recorded in Finland during a three month period in 1962. Factors studied

were: accident frequency, hospitalization rate, and mortality; location and severity of injuries in different categories of road users; duration of hospital treatment, loss of working days, and rate of persistent disability. It was found that accident victims treated by doctors exceeded accidents reported to civil authorities by 26%; that the peak accident time is rush hours; that only one person is injured in 71.7% of accidents; that all age groups were represented; that 39% of victims were hospitalized; that 3.4% of victims died; that multiple injuries took place in 46% of cases; that hospital treatment averaged 11.6 days; that persisting disability rate was 1.9%; that severe injury was highest in pedestrians.

Search terms: Finland; Injury rates; Injury statistics; Injury severity; Injury research; Medical treatment; Injury costs; Accident types; Fatality rates; Injuries by body area; Injuries by accident type; Time of accidents; Multiple injuries; Pedestrian accidents; Accident studies; Disability evaluation; Statistical analysis; Recovery time

1/3 Investigation

HS-010 242 Fld. 1/3; 5/2

HIGHWAY ACCIDENT REPORT. INTERSTATE BUS-AUTOMOBILE COLLISION AND ROLLOVER ON INDIANA ROUTE 57, SOUTH OF PETERSBURG, INDIANA, NOVEMBER 24, 1969

National Transp. Safety Board

1971 37p

Report no. NTSB-HAR-71-4; NTSB-SS-H-7

A bus was traveling southbound on a two lane highway in dense fog and darkness at 40 to 45 mph. While rounding a right hand curve on a downgrade and approaching an intersection the bus driver saw the headlights of an automobile which he thought was entering the highway from the right and coming at him. He steered to the right, applied the brakes; the bus

swerved clockwise, skidded, struck the automobile, which in fact was stopped at the intersection, slid sideways and rolled over in a ditch. The automobile was struck broadside by the bus and slid southward, away from the bus. The bus driver and all occupants were injured during the rollover and an infant was killed. The automobile driver was slightly injured. The probable cause of the accident was that the bus driver misjudged the location of the automobile because of an illusion caused by the fog. Contributing factor was the excessive speed of the bus for road conditions.

Search terms: Intersection collisions; Rural intersections; Bus drivers; Bus accidents; Rollover accidents; Damage; Weather caused accidents; Fog; Reduced visibility; Wet road conditions; Injuries by seat occupation; Passenger fatalities; Passenger injuries; Accident causes; Driver error caused accidents; Speed; Precrash phase; Crash phase; Injury severity; Accident reports

AVAILABILITY: NTIS

HS-010 243 Fld. 1/3; 5/20

MOTOR CARRIER ACCIDENT INVESTIGATION. CARL FRANK OWENS. FATIGUED TRUCK DRIVER, 18, KILLED. ACCIDENT - JUNE 29, 1970-CARTHAGE, TENNESSEE

Bureau of Motor Carrier Safety

1971 11p
Report no. 70-8

On June 29, 1970, at 4:20 a.m., on Interstate 40 on a bridge over Caney Fork River, near Carthage, Tennessee, a tractor-semitrailer combination truck ran off the road, struck the guardrail, returned to the traveled portion of the roadway and sideswiped an automobile which was passing the truck. The truck then crashed through the bridge railing and plunged into the river. The truck driver, 18 years of age, was killed. The driver of the automobile was not injured.

The cause of this accident was fatigue--and the truck driver was underage, unqualified, and inexperienced.

Search terms: Truck accidents; Driver experience; Driver fatigue caused accidents; Truck driver performance; Tractor semitrailers; Driver age; Fatalities

1/4 Locations

HS-010 244 Fld. 1/4

BOOBY TRAPPED HIGHWAYS IN THE "BECKONING COUNTRY"

by Julian A. Waller; Lawrence S. Harris; John J. Oprendeck, Jr.

1970 22p

Supported in part by Insurance Inst. for Highway Safety.

The purpose of this report is to identify the problem of roadside hazards in Vermont. It is recommended that priority should be given to identifying accident locations, that a standard crash investigation form should be used, that highway planning should be coordinated, that all public roads should be inventoried to identify hazards, that a timetable should be established for spot improvement, and that community support for such a program should be sought.

Search terms: Fixed objects; Priorities; Accident report forms; Spot improvement program; Community support; Highway planning; Vehicle fixed object collisions; Highway improvements; Accident location; Roadside hazards; Vermont

HS-010 245 Fld. 1/4; 2/9

COUNTY OF NEVADA. IDENTIFICATION AND SURVEILLANCE MASTER ROAD PLAN. FINAL REPORT

Nevada County Dept. of Public Works, Calif.

1971 52p

A procedure was developed for establishing construction priorities based on identification of high accident locations. Average daily traffic counts were determined for most of the county roads, a road inventory was updated, and road segments were measured for inclusion in the existing maintained mileage program. A priority system has been established for improvements at accident locations.

Search terms: Accident location; Accident rates; Highway improvements; Traffic flow; Traffic surveillance; Traffic surveys; Speed studies; California; Priorities; Maps

1/5 Statistical Data

HS-010 246 Fld. 1/5

1969 TRAFFIC ACCIDENTS AND ACCIDENT RATES ON THE STATE HIGHWAY SYSTEM

Oregon State Hwy. Dept.

1970 1v
Report no. Pub-70-2

This report, designed for comparison of accident rates, is in four parts. The first part is a result of the analysis. The second is a five-year comparison of accident rates by state highway. The third is a listing of both the urban and rural intersectional accidents on the state highway system. Both Part 2 and Part 3 involve only eight months of accident data: March, April, and July through December. The fourth part is a tabulation of the statewide fatal accidents for the 12 months.

Search terms: Accident statistics; Accident rates; Accident location; Rural accidents; Urban accidents; Intersection collisions; Injury statistics; Fatality rates

ACCIDENTS

HSL No. 71-31

HS-010 247 Fld. 1/5

SUOMEN TIELIIKENNEON- NETTOMUDET VUONNA 1969 (ROAD TRAFFIC ACCIDENTS IN FINLAND 1969)

Central Organisation for Traf. Safety in
Finland

1971 47p
Report no. 15

Text in Finnish and English.

Both the road traffic accidents in 1969 and some time series of accidents for the years 1950-1969 are included in this publication. Statistics of road traffic accidents from some other countries in Europe are also included. The source material consists of information about road traffic accidents as reported by the police to the Central Statistical Office. Statistics are given for: road accident fatalities and injuries; types of accidents; injuries by age group; pedestrian injuries; cyclist injuries; accidents by month and province; property damage accidents; types of vehicles involved in road accidents; injuries and fatalities by month, day, and hour; accident causes; age of at fault drivers in injury or fatality accidents; railroad grade crossing accidents; and tractor type road accidents.

Search terms: Accident rates; Accident statistics; Fatality rates; Injury rates; Accident types; Pedestrian accidents; Motorcycle accidents; Month; Property damage accidents; Time of day; Day of week; Bicycle accidents; Age factor in accidents; Intoxication; Weather caused accidents; Railroad grade crossing accidents; Farm vehicle accidents; Accident causes; Finland; Moped accidents; Vehicle registration; Accident costs; International factors; Rural accidents; Urban accidents

HS-010 248 Fld. 1/5

TRAFFIC ACCIDENT FACTS, 1970, CITY OF PHILADELPHIA

Philadelphia Dept. of Streets

1971 38p

Despite increased vehicle registration and mileage, the number of accidents in 1970 remained constant and fatalities dropped 13% to a six-year low of 191. Accident statistics summarized include hourly, daily, and monthly distributions, accident types, accidents by time of day, characteristics of accident victims, contributing factors, type of locality, driver's characteristics, vehicle type, light condition, age groups, sex factors and trends since 1946.

Search terms: Traffic accidents; Accident statistics; Injury statistics; Age factor in accidents; Accident causes; Accident factors; Accident location; Accident prevention; Accident rates; Sex factors in accidents; Hazards; Accident types; Time of accidents; Driver age; Driver characteristics; Pedestrian accidents; Vehicle characteristics; Traffic law violations; Philadelphia; Fatality rates; Environmental factors; Driver sex; Day of week

HS-010 249 Fld. 1/5

TRAFFIC ACCIDENT EXPERIENCE IN THE UNITED STATES

Insurance Information Inst.

1971 13p

Tabulations of traffic deaths, injuries, accidents, and consequent economic losses are shown for 1961 as a base year and 1964-1970. Fatalities are National Safety Council data; other data are estimates based on a cross-section of state accident reports. They are higher than Council figures through inclusion of all known injuries and of accidents on private property. Figures are given for

costs per injury and cost per death. Factors considered in calculating these costs include wage loss, medical expense, insurance costs, property damage, personal income, cost of living.

Search terms: Accident statistics; Injury statistics; Accident costs; United States; Injury costs; Life value; Fatality rates; Property damage accidents; Damage costs; Economic analysis

HS-010 250 Fld. 1/5

ACCIDENTS IN AUSTRALIA: THE NEED FOR RESEARCH

by E. C. Wigglesworth

Published in *Medical Journal of Australia*
v1 p1113-20 (30 May 1970)

7 refs

The dominant role of accidents as a major source of morbidity is demonstrated and discussed. Young males (under 20 years) have three times the average road injury rate, but only three-quarters the average occupational injury rate; no differential involvement exists for young males in vehicular injuries at work; males suffer more injuries than females in every age group, both on the roads and at work. It is suggested that differences in quantitative and qualitative exposure constitute only a partial explanation of differential injury involvement, and the presence of some other systematic causal factor is postulated.

Search terms: Epidemiology; Accident research; Accident types; Accident statistics; Accident rates; Fatality causes; Vehicle accidents; Industrial accidents; Alcoholism; Age factor in accidents; Sex factors in accidents; Injuries by sex; Injuries by age; Australia; Diseases; International factors; Suicide; Hospitals; Injury rates; Fatality rates

HS-010 251 Fld. 1/5

**INTERNATIONAL COMPARISON
OF ROAD ACCIDENT
STATISTICS**

by R. J. Smeed; G. O. Jeffcoate

Organisation for Economic Coop. and
Dev. (France)1969 19p 9 refs
Report no. 34; RR/SYMP/WD/69/2/34

Presented at a symposium on the Use
of Statistical Methods in the Analysis
of Road Accidents, Crowthorne,
Berks., 15-16 Apr 1969.

Extracts from a report by the first
author on road deaths in 16 countries
are presented, followed by a discussion
of statistical techniques used. The
original report comments on the
different definitions used in the various
countries for vehicles, deaths, and
casualties in road accidents, and uses the
results of various investigations on
intervals elapsing between accidents and
deaths in an attempt to obtain
comparable figures for road fatalities.
Possible methods for relating numbers of
road fatalities with other measurable
quantities are discussed and a formula
for predicting the numbers of road
fatalities from the number of motor
vehicles and population is obtained. The
likely errors in the use of the formula are
then discussed.

Search terms: Accident rates;
Accident risk forecasting; Accident
statistics; Fatality rates; Fatality
differentials; International factors;
Vehicle mileage; Population; Accident
survival time; Vehicle registration;
Statistical analysis

HS-010 252 Fld. 1/5; 1/3

**ARE YOUNG DRIVERS REALLY
MORE DANGEROUS AFTER
CONTROLLING FOR EXPOSURE
AND EXPERIENCE?**

by Donald C. Pelz; Stanley H. Schuman

Published in *Journal of Safety Research*
v3 n2 p68-79 (Jun 1971)

30 refs

With a probability sample of 3,000
suburban drivers, driving infractions in
the past year (number of accidents of
any severity and number of violations
plus warnings) were obtained from both
personal interviews and official files and
examined in relation to age for men and
women aged 16-24 and 35-44. Two
non-linear methods were used to control
for exposure - separate analyses within
mileage brackets and an adjustment of
infraction scores by the Multiple
Classification (MCA) program to remove
effects associated with mileage and
driving conditions. Under both
procedures, significant age effects were
found; young men aged 18 and 19 had
more violations than men either younger
or older. When road experience
controlled by age when driving was
learned, the same peak at 18 or 19
appeared except that among men who
learned at 15, the "recommended" age
for driver education, the crash and
violation peaks were delayed one or two
years.

Search terms: Adolescent drivers;
Adult drivers; Traffic law violations;
Driver records; Accident rates; Driver
age; Driver mileage; Driver experience;
Young adult drivers; Male drivers;
Accident risks; Accident risk
forecasting; Statistical analysis

HS-010 253 Fld. 1/5; 1/3

**THE MOTORCYCLE ACCIDENT:
A GROWING PROBLEM**

by Davis W. Clark; John H. Morton

Published in *Journal of Trauma* v11
p230-7 (Mar 1971)

21 refs

During 1968, 3,780 motorcycles were
registered in Monroe County, New York;
at least 207 operators and 19 passengers
were involved in personal injury acci-
dents, including five fatalities. Many

factors caused or contributed to the
accidents, according to police reports.
Statistics on causes, operator's charac-
teristics, kinds of injuries, and motorcycle
characteristics are reported. Because
these accidents involve young, healthy
people - and may scar them for life -
urgent measures of prevention are
essential.

Search terms: Motorcycle accidents;
Accident statistics; Motorcycle
operator fatalities; Motorcycle
operator injuries; Driver experience;
Motorcycle characteristics; Motorcycle
passenger injuries; Motorcycle safety;
Helmets; Accident causes; Head in-
juries; Accident studies; Accident
rates; Accident factors; Accident pre-
vention; New York (state); Male
drivers; Young adult drivers; Adoles-
cent drivers; Injury severity; Recovery
time

HS-010 254 Fld. 1/5; 5/2

**NEW MEXICO SCHOOL BUS
ACCIDENT REPORT SUMMARY.
1969-70 SCHOOL YEAR**

by Bill Loshbough

New Mexico State Dept. of Education

1970 24p

The total number of accidents was
slightly less than in 1968-69 even though
the number of school buses and the total
miles traveled increased over the
previous year. During this same period,
New Mexico had the highest traffic
fatality increase in the nation. Sixty-two
of the accidents were classified as
non-preventable, and sixty-three were
classified as being preventable on the
part of the school bus driver.

Search terms: School bus accidents;
School bus drivers; Accident statistics;
Driver age; Driver sex; Month; Driver
error caused accidents; Weather caused
accidents; Accident types; Road
conditions; Loading areas; Injury
statistics; Day of week; Time of
accidents; Environmental factors;
Vehicle mileage; Accident rates;
Fatality rates; Accident location

2/0 HIGHWAY SAFETY

2/1 Breakaway Structures

HS-010 255 Fld. 2/1; 2/5; 1/5

THE STATE-OF-THE-ART IN THE DESIGN AND PERFORMANCE OF SAFER LUMINAIRE SUPPORTS

by Thomas C. Edwards

Texas A and M Univ. Texas Transp. Inst.

1969 37p 14 refs

Presented at the Second Western Summer Meeting of the Highway Research Board, Salt Lake City, 11-13 Aug 1969.

The state-of-the-art in safer luminaire support development is presented. The results of 31 full-scale collision tests are summarized. These tests are grouped according to the base concept employed; flanged bases (steel and aluminum), aluminum transformer bases, aluminum inserts, steel progressive-shear bases, notched bolts, and slip bases. Statistics for a total of 185 luminaire support accidents are presented. These data aid in establishing the effectiveness of breakaway concepts in reducing highway injuries. A mathematical model of the vehicle-luminaire support collision is used to extend the knowledge of vehicle and support response not covered by full-scale tests. Criteria for the design of safe luminaire supports are presented.

Search terms: Luminaires; Pole impact tests; Breakaway light poles; Accident statistics; Injury statistics; Mathematical models; Vehicle light pole collisions; State of the art studies

HS-010 260 Fld. 2/1; 2/5

DEVELOPMENT OF DESIGN CRITERIA FOR SAFER LUMINAIRE SUPPORTS

by Thomas C. Edwards; J. E. Martinez; William F. McFarland; Hayes E. Ross, Jr.

Texas A and M Univ.

1969 92p 23 refs
Report no. NCHRP-77; NAS-NRC-Pub-309-01773-4

Sponsored by the American Assoc. of State Hwy. Officials in cooperation with the Bureau of Public Roads.

Preliminary research that was conducted to develop safer luminaire supports has established that, to insure low impact resistance, it is necessary to incorporate a base which will break away in a collision, but which possesses sufficient strength to resist static and wind-induced loads. Concepts that have been developed and accepted by at least one state in the U. S. can be broadly classified as: frangible insert bases; progressive-shear bases; aluminum shoe bases; and slip points. Full-scale tests have been conducted in such a manner that a comparative evaluation could be made of the four basic concepts. This study has shown that the collision response of a vehicle and luminaire support can be predicted with acceptable accuracy. Design criteria have been formulated, which, if prudently applied, will result in a design that will yield adequate safety.

Search terms: Poles; Breakaway light poles; Breakaway structures; Energy absorption; Impact velocity; Pole impact tests; Loads (forces); Aluminum; Steels; Concretes; Deformation; Vehicle weight; Severity indexes; Damage; Anthropomorphic dummies; High speed photography; Sensors; Time lapse photography; Benefit cost analysis

AVAILABILITY: HRB

2/4 Design and Construction

HS-010 256 Fld. 2/4

DEVELOPMENT OF A HYDRAULIC-PLASTIC BARRIER FOR IMPACT-ENERGY ABSORPTION. FINAL REPORT

by C. Y. Warner; J. C. Free

Brigham Young Univ.

1970 132p
Report no. PB-192 479

An extensive design effort was directed toward optimization of an automobile crash impact cushion. Occupant response, the most important measure of a successful design, and design restrictions and qualifications demonstrated versatility and economically attractive features. Comparison of a computer model of the behavior of the cushion to full-scale collision measurements showed the model to be a good representation for head-on crashes. Comparisons show the water-plastic unit to be effective across the spectrum of impacting vehicle momenta, and demonstrate that it uses almost all available stopping distance for impacts between 30 and 70 mph, for vehicles weighing 2,000 to 6,000 pounds. The design appears to be near optimum.

Search terms: Water cushions; Head on collisions; Barrier collision tests; Impact tests; Impact protection; Impact velocity; Computerized simulation; Impact attenuators; Vehicle weight

AVAILABILITY: NTIS

HS-010 257 Fld. 2/4

DYNAMIC TESTS OF AN ENERGY-ABSORBING BARRIER EMPLOYING STEEL DRUMS

by Eric F. Nordlin; James W. Woodstrom; Robert N. Doty

Published in *Highway Research Record* n343 p123-41 (1971)

15 refs

Sponsored by Committee on Traffic Safety Barriers and Sign, Signal and Lighting Supports and presented at the 50th annual meeting of Highway Research Board.

The results of three full-scale vehicle impact tests at 54 to 64 mph of an energy-absorbing barrier employing 55-gal tight-head drums are reported. The head-on and angle impacts into the nose of the barrier resulted in vehicle passenger-compartment decelerations less than the 12-g limit suggested by the Federal Highway Administration. Vehicle damage was moderate. The vehicle remained stable and upright during impact. Barrier effectiveness in reducing the severity of most impacts is such that it should be used operationally on an experimental basis. However, future refinements in the design need to be made, particularly with regard to redirection of vehicles that collide with the side of the barrier. Impacts into the side of the barrier were not satisfactory.

Search terms: Energy absorbing barriers; Barrier design; Barrier collision tests; Barrier tests; Head on collisions; Side impact collisions; Drums; Deceleration tolerances; Dynamic tests

HS-010 258 Fld. 2/4; 5/22

A COMBINED APPROACH TO THE OPTIMISATION OF TYRE AND PAVEMENT INTERACTION

by T. Holmes; G. Lees; A. R. Williams

Birmingham Univ. (England); Dunlop Co. Ltd. (England)

1971 55p 76 refs

Prepared for presentation at Symposium on Tread Wear and Traction, American Chemical Society, Miami Beach, Apr 1971.

The development of pavement surfacing technology with regard to skid resistance and advances in the understanding of tire-pavement interaction are reviewed. The influence of these advances on the construction of pavement surfaces and tire design in Great Britain is discussed. A variable speed internal drum machine has been developed to control some variables in roadhold measurements and

for laboratory testing of pavement surfacings and tread compounds. Electron microscope studies of pavement polishings are related to skid resistance measurements. Types of tread compound abrasion are reviewed. The concept of the three zone contact path is discussed with regard to tire construction, tread patterns, and pavement surfaces. Artificial and natural aggregates for pavements will have effects on tread abrasion rates.

Search terms: Tire design; Laboratory tests; Tire pavement interface; Tire test equipment; Tire skid resistance; Tire wear; Tire treads; Tire traction; Pavement damage; Pavement skid resistance; Pavement surface texture; Abrasion; Aggregates; Skid resistance tests; Tire tests; Pavement tests; Great Britain; Pavement wear; Wet road conditions; Reverted rubber

HS-010 259 Fld. 2/4; 5/22

SKIDDING ACCIDENTS. CONSIDERATIONS ON ROAD SURFACE AND VEHICLE CHARACTERISTICS

Stichting Wetensch. Onderz. Verksrvtghd. (Neth.)

1969 58p 17 refs
Report no. 1970-4

Various investigations have shown that, among other factors, the skidding resistance of the road surface influences the likelihood of skidding and hence of an accident. However, it has not yet been possible on the basis of these investigations to determine a definite "minimum necessary value" for the skidding resistance of a road surface. Nevertheless, the Working Group on Tyres, Road Surfaces and Skidding Accidents considers it very important for a fixed minimum skidding resistance for the surfaces of all roads in the Netherlands to be recommended immediately, even if this value is provisional. The guide value already

employed by the State Road Laboratory is recommended: this minimum skidding resistance for a wet road surface, expressed as the coefficient of friction, measured with a standardized patterned measuring tire at 86% longitudinal slip and a road speed of 50 km/h, is 0.51. A research program or skid prevention is recommended.

Search terms: Skidding accidents; Wet road conditions; Pavement skid resistance; Pavement friction; Coefficient of friction; Tire road conditions; Pavement surface texture; Pavement skidding characteristics; Vehicle road interface

2/5 Lighting

HS-010 261 Fld. 2/5; 5/10; 3/4

INTERACTION BETWEEN FIXED AND VEHICULAR ILLUMINATION SYSTEMS. PHASE I - INTERIM REPORT

by Eugene Farber; Vincent Gallagher; Arno Cassel

Franklin Inst. Res. Labs.

1971 111p 188 refs
Contract FH-11-7599

The literature is reviewed on nighttime highway lighting conditions relative to driver behavior, on the state-of-the-art in highway lighting methods and standards, and on vehicle lighting practices. A research plan is given for Phase II of the project, concerned with the relations between illumination variables and driving tasks. The literature review revealed that drivers are sensitive to illumination conditions not only in target detection performance but also in psychophysical and gap acceptance judgments and vehicular control. The most important variables were found to be the presence or absence of external illumination and glare from opposing vehicles. There is some evidence that under certain conditions vehicle headlights and external illumination may interact unfavorably.

2/5 Lighting (Cont'd.)**HS-010 261 (Cont'd.)**

Search terms: Highway lighting; Vehicle lighting; Sight distances; Reviews; Visibility; Vehicle control; Gap acceptance; Target detection; Driver behavior; Psychophysical discrimination; Night driving; Night visibility; Driving task analysis; Highway lighting standards; Headlamp design; State of the art studies; Headlamp glare

2/7 Meteorological Conditions**HS-010 262 Fld. 2/7; 2/9; 1/5****THICK FOG AND ITS EFFECT ON TRAFFIC FLOW AND ACCIDENTS**

by P. J. Codling

England Road Res. Lab.

1971 27p 13 refs
Report no. RRL-LR-397

The frequency and duration of thick fog (visibility less than 200m) in Great Britain has been analyzed for the period 1958-67. The highest mean annual number of days which thick fog at recording sites was 17 at 0900 GMT at Watnall (Nottinghamshire). Generally thick fog was found to be relatively infrequent, patchy, rarely widespread and of short duration. Its frequency inland has been falling in recent years, probably because of the Clean Air Act, 1956. Four thick fogs of 24 hour duration on weekdays reduced traffic flow by about 20 percent. (Previous reports had indicated considerably greater reductions at weekends.) The numbers of fatal and serious accidents and casualties were reduced but slight accidents and casualties increased significantly. Accidents in darkness and those involving pedestrians were reduced significantly whereas those involving more than two vehicles were increased

significantly. Overall, there was no change in the fatal and serious accident rate per unit of traffic whereas the slight injury and total accident rates increased by about 70 and 50 percent respectively.

Search terms: Fog; Reduced visibility; Weather caused accidents; Traffic flow; Accident rates; Fatality rates; Injury rates; Injury severity; Accident statistics; Time of day; Great Britain

2/9 Traffic Control**HS-010 263 Fld. 2/9****THE FEASIBILITY OF MINIMUM SPEED LIMITS BY LANE ON MULTIPLE LANE HIGHWAYS**

California Div. of Highways

1966 19p
Report no. HPR-1(4); C-3-10

House Resolution No. 133, 1965
Regular Session.

The benefits of minimum speed limits by lane could be more uniform speeds in each lane, less tailgating and platoons of closely spaced vehicles, fewer lane changing maneuvers, and less passing on the right. Large signs were erected overhead and before and after data gathered on four, six, and eight lane freeways. Average speeds tended to decrease, vehicles moving at minimum speed in the fast lane impeded traffic, and traffic shifted left, away from the slow lane. Because of these disadvantages, lack of benefits, and cost and hazards associated with signing, placement of minimum speed signs by lane is not recommended.

Search terms: Minimum speed limits; Lane usage; Freeway driving; Speed signs; Vehicle spacing; Traffic lanes; Traffic flow; Traffic engineering; Traffic volume; Driver behavior; Platoons; California; Feasibility studies; Speed patterns

HS-010 264 Fld. 2/9**AN EFFECTIVE TRAFFIC SAFETY PROGRAM**

Kustom Signals, Inc.

n.d. 36p

A radar system for speed law enforcement, called the PREFECT Traffic Safety Program, is described in a manufacturer's brochure. Speed and speeding violations are said to be involved in more than half of traffic accidents and fatalities, and enforcement of speed laws is urged as an effective traffic safety program. The operation of the radar system is described.

Search terms: Radar; Radar operation; Traffic law violations; Traffic surveillance; Traffic law enforcement; Law enforcement effect on accident rates; Speed limits; Speed recorders; High speed caused accidents; Police traffic services

HS-010 265 Fld. 2/9**ANALYSIS AND PROJECTION OF RESEARCH ON TRAFFIC SURVEILLANCE, COMMUNICATION, AND CONTROL**

by Karl Moskowitz; John Laughland; Roy Jorgensen

Jorgensen (Roy) and Associates

1970 58p 52 refs
Report no. NCHRP-84; NAS-NRC-Pub-309-01782-3

Sponsored by the American Association of State Highway Officials in cooperation with the Bureau of Public Roads.

To reduce traffic congestion and accidents, experiments in surveillance and control have been performed in many countries. Freeway ramp control offers immediate promise, increasing capacity and reducing accidents by limiting entry rates. Area control of traffic signals by computerized signal timing is promising

and is considered one of the best areas for development of advanced control methods. Communication between vehicles, using devices which inform a following driver of his rate of closure and distance to the car ahead, is also described. Areas recommended for future research are: ramp control on freeways; freeway surveillance and communication with drivers; removal of disabled vehicles from congested freeways; improvement in timing traffic signals; improved communication between vehicles.

Search terms: Freeways; Driver aid systems; Disabled vehicles; Highway communication; Distance headways; Area traffic control; Computer controlled signals; Traffic capacity; Traffic congestion; Traffic control; Traffic surveillance; Ramp control; Traffic signal timing; Traffic signal networks

HS-010 266 Fld. 2/9; 1/3

ACCIDENTS, SPEED DEVIATION AND SPEED LIMITS

by Leonard B. West, Jr.; J. W. Dunn

Published in *Traffic Engineering* v41 n10 p52-5 (Jul 1971)

3 refs

Magnetic loop detectors linked to a computer were used to study the relationship between accident involvement rate and deviation from the mean traffic speed. An accident investigation team studied 36 accidents of which 23 were correlated with vehicle speeds. Very high involvement was associated with high differential speeds in accidents at intersections. Within 15 mph deviation, accident rates were approximately the same as the average speed. Since standard deviation was six to eight mph, upper and lower speed limits at 85th and 15th percentiles and enforcement at 95th and 5th percentiles is recommended.

Search terms: Accident rates; Accident causes; High speed caused accidents; Low speed caused accidents; Speed computers; Speed differential; Speed limits; Speed patterns; Spot speed characteristics; Speed sensors; Turning; Indiana; Intersection collisions; Magnetic loop detectors; Speed studies

2/11 Traffic Records

HS-010 267 Fld. 2/11

TRAFFIC RECORDS—A CONCEPTUAL VIEW

by A. Dewey Jordan; James E. Wilson

Published in *Traffic Engineering* v41 n10 p26-9 (Jul 1971)

1 ref

The federal safety standard for traffic records establishes minimum requirements for state highway safety programs to ensure that data on drivers, motor vehicles, highways, and traffic accidents can be gathered and used effectively. Conceptually, traffic records include driver records; vehicle identification, characteristics, ownership, and history—accidents, inspection, defects and repairs; highway and road identification, features, traffic history—violations, accidents, defects, and repairs; accident identification, persons, vehicles, injuries, environment, and emergency responses. These data elements in great detail and with linkage elements are essential to generate useful outputs for planning and action.

Search terms: Traffic records; Data acquisition; Safety standards; Driver records; Vehicle identification; Accident records; Accident location; Vehicle characteristics; Highway characteristics; Driver characteristics

3/0 HUMAN FACTORS

HS-010 268 Fld. 3/0

HIGHWAY SAFETY MANPOWER AND TRAINING

National Safety Council

1968 28p

Substantial increases in manpower and training are required to meet the National Highway Safety Bureau standards. Manpower deficiencies are examined, training shortcomings listed, and reasons given for present deficiencies and shortcomings. University highway safety centers must perform the important functions of research and development, extension services, and education and training. A recommended plan of action is set forth.

Search terms: Manpower utilization; Personnel; Highway safety programs; Education; Safety standards

3/1 Alcohol

HS-010 269 Fld. 3/1

ALCOHOL AND ROAD ACCIDENTS

British Medical Assoc.

Published in *British Medical Journal* n5168 p269-72 (23 Jan 1960)

This is an abridgement of the report "Relation of Alcohol to Road Accidents" undertaken by the Special Committee of the British Medical Association, together with the committee's conclusions. The report examines the evidence on the relation of alcohol to road accidents under two main headings: the effect of alcohol on driving performance or skills resembling driving; and statistical evidence of the proportion of accidents in which it can be established that one or more persons involved had been drinking alcohol prior to the accident.

Search terms: Drinking drivers; Blood alcohol levels; Driver performance; Driver reaction time; Driver skills; Accident causes; Alcohol laws; Alcohol effects; Driver intoxication

HS-010 270 Fld. 3/1

THE DRINKING DRIVER ON THE DRIVING DRINKER? ALCOHOL, ALCOHOLISM AND OTHER FACTORS IN ROAD ACCIDENTS

by F. A. Whitlock; J. L. Armstrong; J. I. Tonge; M. J. J. O'Reilly; A. Davison; N. G. Johnston; R. P. Billoft

Published in *Medical Journal of Australia* v2 n5 p5-16 (3 Jul 1971)

27 refs

This study investigated the age and drinking habits of persons killed in traffic accidents and the evidence of alcohol-caused liver damage in these subjects. The records and accident data of 120 fatalities (drivers, passengers, and pedestrians) in Brisbane were examined over a period of 14 months. A social worker obtained data about past health, drinking habits, and other details from friends and families of the deceased. Only six subjects showed cirrhosis of the liver, of whom two were drivers. It was not possible to confirm that major liver damage resulting from alcohol was a common finding among drivers killed on the roads. The overall impression was that young men, not necessarily alcoholics or heavy drinkers, made a disproportionate contribution to driver fatalities after an unusual amount of alcohol had been consumed.

Search terms: Drinking drivers; Liver cirrhosis; Alcoholism; Social drinking; Drinking pedestrians; Blood alcohol levels; Autopsies; Driver intoxication; Problem drivers; Brisbane; Sociological factors; Driver records; Driver fatalities; Passenger fatalities; Fatalities by age; Fatalities by sex; Single vehicle accidents; Male drivers; Driver age; Young adult drivers

HS-010 271 Fld. 3/1

IMPLIED CONSENT LAW

Anonymous

Published in *Ohio State Medical Journal* v64 p605-8 (May 1968)

The implied consent law became effective in the state of Ohio in 1968. The law says, in effect, that anyone operating a motor vehicle on a public highway in the state of Ohio has given implied consent to submit to a chemical test to determine the alcoholic content of his blood. It is important for the physician or nurse to remember that the statute affords no immunity from liability for the withdrawal of blood. Consequently, before withdrawing blood, they should be satisfied that the person from whom the blood is taken has given his consent and that the consent is with complete understanding of the consequences. A text of the pertinent provisions of the law is included in this article. The constitutionality of the law is discussed.

Search terms: Implied consent laws; Constitutional law; Court decisions; Liability; Alcohol blood tests; Drinking drivers; Physicians; Driver intoxication

HS-010 272 Fld. 3/1; 4/7

BLOOD ALCOHOL LEVELS IN DRIVERS NOT INVOLVED IN ACCIDENTS

by Reginald G. Smart; Wolfgang Schmidt

Published in *Quarterly Journal of Studies in Alcohol* v31 n4 p968-71 (Dec 1970)

8 refs

In five studies of drivers not involved in accidents the blood alcohol levels fitted the log normal expectancy, suggesting that the proportion of alcohol-impaired drivers can be reduced only by reducing the mean blood alcohol levels of all drivers.

Search terms: Blood alcohol levels; Drinking drivers; Logarithms; Driver intoxication

3/3 Cyclists

HS-010 273 Fld. 3/3; 3/4

THE MOTORCYCLE SYNDROME

by Armand M. Nicholi 2nd

Published in *American Journal of Psychiatry* v126 n11 p1588-95 (May 1970)

31 refs

Presented to American Psychiatric Assoc., Miami Beach, 5-9 May 1969.

Findings are presented of an in-depth study of nine accident-prone male motorcyclists involving a previously undescribed syndrome in an attempt to elucidate the psychological causes of the rapidly rising rate of motorcycle accidents and deaths. Examining the reasons why the motorcycle is particularly dangerous to these patients, the paper explores the specific ego defect common to them, their adaptive and defensive use of the cycle, the cycle's symbolic meaning, and the unconscious conflicts it reactivates. This syndrome gives clues to understanding accident-prone drivers of other motor vehicles.

Search terms: Motorcycle operators; Accident proneness; Driver personality; Motorcycle accidents; Psychological factors; Emotions; Aggression; Impulsiveness; Problem drivers; Fear; Male drivers

3/5 Driver Education

HS-010 274 Fld. 3/5

HUMAN INFORMATION PROCESSING CAN AID DRIVER EDUCATION

by James R. Williams

Published in *American Society of Safety Engineers Journal* v14 p6-10 (Jun 1969)

4 refs

DECEMBER 17, 1971

A model for information processing in man is described and related to driver education. To support the theoretical constructs, the model, derived from an investigation of physiological and psychological literature, is described in terms of how it relates to human perception. The model fits presently available experimental data reasonably well and has use in improvement of driver education as well as in industry. The functions studied are detection, recognition, identification, memory, and response.

Search terms: Driver education; Perception; Driving task models; Driving simulation; Driving simulation research; Driver performance; Driver skills; Psychological factors; Simulation models; Recognition; Memory

HS-010 275 Fld. 3/5

DRIVING SIMULATION: AN OVERVIEW

by Thomas R. Schori

Published in *Behavioral Research in Highway Safety* v1 n4 p236-49 (Winter 1970)

51 refs
Grant PHS-UI-01001-03

An increasing number of reports dealing with driving simulation are appearing in the literature. However, this area is so new that many readers are not familiar with the terminology employed or the nature of the simulation referred to in these reports. This paper is intended to present an overview of the field of driving simulation for those readers. Classification of simulators is discussed as well as a brief description of several types of simulators. Training aspects of simulation are briefly discussed but the emphasis of this paper is on research versions of driving simulators.

Search terms: Driving simulation; Driving simulators; Classroom driver instruction

3/6 Driver Licensing

HS-010 276 Fld. 3/6; 3/9

EVALUATING THE OLDER DRIVER

by J. Stannard Baker

Published in *Traffic Digest and Review* v13 n3 p23-5, 30 (Mar 1965)

Periodic examinations that are more than perfunctory are costly. Hence selective re-examination of drivers of all ages seems promising, based on accident-offense records and on age. Specific problems of older drivers are vision, reaction time, bad habit patterns, poor physical condition, overcaution, and fatigue. Subtle degeneration can lead to slips in performance—such as pressing accelerator rather than brake—so rare in occurrence that testing fails to reveal them. A clearer understanding of older drivers' accidents is needed with better methods for detecting those who continue to drive beyond the limits of their reduced capabilities.

Search terms: Aged drivers; Age factor in accidents; Driver age; Accident factors; Driver errors; Driver performance; Driver license examination; Driver license renewal; Driver physical fitness; Driver records; Driver reexamination; Driver fatigue; Driver reaction time; Vision age changes

3/11 Pedestrians

HS-010 277 Fld. 3/11; 1/3

PEDESTRIAN ACCIDENT PREVENTION

by Jason C. Yu

Published in *Traffic Quarterly* v25 n3 p391-401 (Jul 1971)

10 refs

Each year, greater numbers of people lose their lives from some kind of motor vehicle involvement; always many of

OTHER SAFETY RELATED AREAS

them are pedestrians. The causes of pedestrian-vehicle accidents are examined in this report. In achieving a sound pedestrian safety program, engineering control, pedestrian education, and law enforcement must be correlated. State legislatures and local governments hold the responsibility to enact laws and regulations which provide for the necessary control and protection of pedestrians. Regulations for pedestrians should be practical and justified; only such regulations can be expected to achieve voluntary observance and obedience.

Search terms: Accident prevention; Pedestrian accidents; Pedestrian control; Pedestrian age; Pedestrian behavior; Pedestrian safety; Crosswalks; Safety zones; Sidewalks; Pedestrian control signals; Pedestrian bridges; Pedestrian education; School crossing protection; Traffic law enforcement; Drinking pedestrians

4/0 OTHER SAFETY-RELATED AREAS

4/1 Codes and Laws

HS-010 278 Fld. 4/1

THE CONVENTION ON ROAD TRAFFIC AND THE UNIFORM VEHICLE CODE

National Com. on Uniform Traf. Laws and Ordinances

Published in *Traffic Laws Commentary* n70-9 p1-38 (27 Oct 1970)

refs
Contract FH-11-6869

The convention on Road Traffic and the Uniform Vehicle Code are compared; conflicts and differences are noted. The convention is a proposed international agreement, sponsored by the United Nations. United States participation in the convention appears desirable, although many reservations and understandings would be needed to make it reasonably consistent with the

OTHER SAFETY RELATED AREAS

HSL No. 71-31

4/1 Codes and Laws (Cont'd.)

HS-010 278 (Cont'd.)

code and state laws. By making only vital reservations and by improving the code where the convention is superior, better traffic safety and efficiency in the United States and other countries would result.

Search terms: Convention on Road Traffic; International factors; International compacts; Uniform Vehicle Code; Law uniformity; State laws; Vehicle laws; Traffic laws

HS-010 279 Fld. 4/1; 3/6

DRIVER LICENSE EXAMINATIONS

National Com. on Uniform Traf. Laws and Ordinances

Published in *Traffic Laws Commentary* n71-2 p1-7 (27 Jul 1971)

refs

Contract FH-11-6869

Comparison of state laws with the Uniform Vehicle Code, which has been improved over the years, indicates that many states are far behind, particularly in rules of the road and driver licensing. Numbers of states complying with the code's licensing provisions are: examination of driver license applicants 47, eye test 34, license applicant's ability to read and understand traffic control devices 37, knowledge of safe driving practices 5, knowledge of traffic laws 38, road test demonstrating the ability to drive safely 37, class-of-vehicle road test 11, and other tests (physical and mental) 30. Implementation of the code's recommendations in all areas of driver licensing should reduce highway deaths and injuries.

Search terms: Driver license laws; State laws; Law uniformity; Uniform Vehicle Code; Driver license examination; Driver physical fitness; Driver mental fitness; Driver tests; Vision tests; Driver licensing

HS-010 280 Fld. 4/1; 5/4

HORNS

National Com. on Uniform Traf. Laws and Ordinances

Published in *Traffic Laws Commentary* n71-1 p1-5 (15 Jun 1971)

refs

Contract FH-11-6869

State laws on horns are reviewed and compared with the Uniform Vehicle Code in hope of restoring this device to its proper use as a warning device. Code provisions and number of states observing them are: horn required—all except Hawaii; adequate performance—all except Hawaii and Massachusetts; not too loud or harsh—44 states; use when needed for safety—34 states; and use prohibited otherwise—45 states. Court decisions and state laws are cited.

Search terms: Horns; State laws; Law uniformity; Uniform Vehicle Code; Emergency signaling devices; Vehicle noise; Horn usage

HS-010 281 Fld. 4/1; 5/16

REGISTRATION INFORMATION

National Com. on Uniform Traf. Laws and Ordinances

Published in *Traffic Laws Commentary* n70-7 p1-8 (19 Aug 1970)

refs

Contract FH-11-6869

Tabular reviews compare registration requirements of the Uniform Vehicle Code and state laws. Alabama, Tennessee, and Virginia have been omitted as they lack comparable law or provisions. Registration information is required about owner, vehicle, and to determine whether vehicle should be registered and owner have title. Virtually all states require the most basic information but vary considerably in

amplifying detail. Financial statements of the National Committee on Uniform Traffic Laws and Ordinances for 1969 are appended.

Search terms: Vehicle registration; Uniform Vehicle Code; State laws; Vehicle laws; Law uniformity

HS-010 282 Fld. 4/1; 5/20

FARM VEHICLE EQUIPMENT

National Com. on Uniform Traf. Laws and Ordinances

Published in *Traffic Laws Commentary* n70-8 p1-11 (5 Oct 1970)

refs

Contract FH-11-6869

State laws requiring lights, reflectors, and emblems on farm tractors and other self-propelled farm vehicles are reviewed. The Uniform Vehicle Code requires farm vehicles to be equipped with warning devices. Vehicles operated at night are required to have at least two headlights, but only 11 states require headlights. The Uniform Vehicle Code requires one red tail lamp and two red reflectors; only one state requires this, while the other states have lesser requirements or none. The Uniform Vehicle Code requires flashing lights and a slow-moving vehicle emblem on farm vehicles operating on the highway, but most states do not. The laws in a great number of states have not kept pace with needs for lighting and warning systems on farm vehicles.

Search terms: Uniform Vehicle Code; Law uniformity; State laws; Vehicle laws; Farm vehicles; Slow moving vehicles; Lighting regulations; Warning systems; Farm tractors; Headlamp regulations; Flashing warning signals; Reflectors; Red lamps; Taillamps

DECEMBER 17, 1971

4/2 Community Support

HS-010 283 Fld. 4/2

ILLINOIS YOUTH TRAFFIC SAFETY CONFERENCE, SPRINGFIELD, 13-14 MAY 1966. FINAL REPORT

Illinois Div. of Highways

1966 38p

The objectives of the Illinois Youth Traffic Safety Conference were: to develop a permanent medium for state direction and coordination of regional, county, and local youth traffic safety activities in Illinois; to expedite participation of all high schools and local communities in effective traffic safety activities; to stimulate youth interest in traffic safety by involving them actively in the search for a solution to the problem, thus helping them to help themselves. The theme of the conference was "accept your responsibility."

Search terms: Conferences; Safety campaigns; Safety education; Adolescent drivers; High school drivers; Highway safety programs

HS-010 284 Fld. 4/2; 4/4

THE FEDERAL-STATE HIGHWAY SAFETY PARTNERSHIP IN NORTH CAROLINA

by Elbert L. Peters, Jr.

Published in *Traffic Digest and Review* v19 n7 p15-8 (Jul 1971)

Highway safety programs in North Carolina since the Highway Safety Act of 1966 are described. Electronic speed metering equipment was bought for 48 political subdivisions; a training course in accident investigation procedures has been offered with 1,200 out of the State's 8,000 police officers participating; chemical test equipment to use in the fight against drinking drivers has been purchased. Most popular of all,

24 jurisdictions are receiving federal matching funds to provide emergency medical service. Another major project has been the establishment of six regional driver education centers.

Search terms: Federal state relationships; Federal aid; Highway Safety Act of 1966; Financing; Grants; Alcohol chemical tests; Driver education; Emergency medical services; Highway safety programs; North Carolina; Drinking drivers; Police training; Speed sensors; Accident investigation training

4/5 Information Technology

HS-010 285 Fld. 4/5; 1/3

ROAD ACCIDENT STATISTICS WORKING PARTY. INTERIM REPORT

by J. B. Peers; E. D. Turner

Greater London Council Dept. of Hwys. and Transp.

Aug 1968 24p

A new police accident reporting procedure started on 1 January 1969. It was computer oriented and included an accurate location. The decisions taken are described and the reasons for them outlined. The major part of the report deals with the form of output provided and the flexibility offered to the user. In the new report, the system will perform three separate functions: it will provide the main data channel to the Greater London Council and the Boroughs of police accident information in detail; an automatic sorting and tabulation procedure will provide collected information on the number of accidents which occurred on a particular length of road or under specified conditions; a statistical monitor program will find the accident blackspots and, by use of standard indices of performance, will indicate which design changes are most likely to give economic reductions in accidents.

OTHER SAFETY RELATED AREAS

Search terms: Computerized records management; Computerized safety research techniques; Data acquisition; Data processing; Automated accident records; Information retrieval; Electronic accident analysis; Great Britain; Accident report forms; Data analysis; Costs

HS-010 286 Fld. 4/5; 1/3; 1/5

COLLISION DATA ANALYSIS PROGRAM - A PROPOSAL TO AMA

Michigan Univ. Hwy. Safety Res. Inst.

1970 47p

This document describes current status and plans for collision data acquisition and evaluation, administration and cost, computer software and hardware, dictionaries of two files (Oakland and Washtenaw Counties), gives an example of analyst-computer problem solving, and includes a sample of HIT Lab Reports for January 1, 1970.

Search terms: Accident reports; Collisions; Accident statistics; Data analysis; Automated accident records; Data acquisition

4/8 Transportation Systems

HS-010 287 Fld. 4/8

JOINT LEGISLATIVE COMMITTEE ON MASS TRANSPORTATION, STATE OF NEW YORK. FIRST ANNUAL REPORT TO THE LEGISLATURE

New York State Jnt. Leg. Com. on M.V. & Traf. Saf.

1968 101p

Report no. Legislative-Doc-1968-13

The committee studied the operations of existing systems, laws and authorities, revenues and expenditures, as a basis for a master plan of unification and coordination to form a balanced

4/8 Transportation Systems (Cont'd.)

HS-010 287 (Cont'd.)

transportation system. Analysis of bus, automobile, rail, air and marine transportation systems included considerations of intergovernmental relations and land use. Demonstration projects and financing are discussed; transportation developments in other states and countries are described.

Search terms: Public transportation; Transportation systems; Transportation planning; Transportation system costs; Transportation studies; Transportation problems; Rapid transit systems; High speed ground transportation; Railroad passenger service; Air transportation; Highway transportation; Urban transportation; Marine transportation; Financing; Demonstration projects; Land usage; New York (state); Federal role; Tube transportation

5/1 VEHICLE SAFETY

5/1 Brake Systems

HS-010 288 Fld. 5/1

DEVELOPMENTS TO UTILIZE HYDRAULIC SERVICE BRAKES FOR HEAVY DUTY OR HIGH FREQUENCY PARKING

by Fred W. Cords

Minnesota Automotive, Inc.

Published in HS-002 163, *Utility Vehicle Workshop: Parking Brakes* (SP-296), p1-7

Report no. SAE-680162; SP-296

Presented at SAE Automotive Engineering Congress, Jan 1968.

With the ever increasing demand for more usability and flexibility of commercial vehicles, attention had focused on the need for a dependable

hydraulic operational parking brake. One such system is the utilization of the existing hydraulic service brakes. This paper discusses several means of accomplishing this end. Hydraulic brake locks, usually operated electrically or manually, retain brake pressure and can be designed for emergency stopping use as well as parking.

Search terms: Brake controls; Brake design; Brake locks; Brake systems; Electrohydraulic brake systems; Emergency brakes; Holding brakes; Hydraulic brakes; Parking brakes

HS-010 289 Fld. 5/1

HEAVY DUTY DISC BRAKES START FLEET SERVICE

by Jack Lyndall

Published in *Fleet Owner* v66 n7 p51-8 (Jul 1971)

Heavy duty disc brakes are now in regular route service on five buses of the Southern California Rapid Transit District, Los Angeles, and heavy duty trucks with disc brakes are running in several manufacturers' private fleets. The advantages of disc brakes, their features, and their performance are discussed.

Search terms: Disc brakes; Stopping distance; Vehicle stability; Brake temperature; Brake lining wear; Truck brakes; Heavy duty vehicles; Brake wear

HS-010 290 Fld. 5/1; 3/2

HUMAN FACTORS CONSIDERATIONS FOR A COMBINED BRAKE-ACCELERATOR PEDAL

by S. Konz; N. Wadhera; S. Sathaye; S. Chawla

Published in *Ergonomics* v14 n2 p279-92 (Mar 1971)

21 refs

The results of a series of nine experiments over a three-year period are reported. Experiments one through six, previously published, indicated that a pedal which actuated an accelerator upon depression of the toe and actuated the brake upon depression of the heel saved 0.2 sec (one car length at 60 mph) over the conventional separate controls. Other experiments investigated the effects on reaction time of pedal angle, location, and activating forces to determine optimum values. A dual-fulcrum design was recommended; its wideness allows operation by either foot.

Search terms: Human factors engineering; Brake pedal design; Control location; Ergosphere; Driver reaction time; Seat positioning; Pedal force; Accelerator pedal design; Accelerator location; Time factors

5/3 Cycles

HS-010 291 Fld. 5/3; 3/5

COMMON SENSE TIPS FOR SAFE SPORTCYCLING

by Jim Jingu; Don Gately

Yamaha International Corp.

1967 35p

There were two million motorcycles and scooters in the United States in 1966, but few training courses for operators. Not only are many motorcyclists insufficiently trained; automobile drivers often cause accidents when they don't see motorcyclists. Safe cycling involves making use of the sportcycle's advantages over automobiles, preventive maintenance, protective clothing, good instruction and much practice, defensive driving, and careful off-the-road driving.

Search terms: Motorcycle operator education; Motorcycle safety; Motorcycle characteristics; Motorcycle inspection; Motorcycle maintenance; Motorcycle riding techniques;

Helmets; Motor scooters; Defensive driving; Accident causes; Traffic laws; Protective clothing

5/4 Design

HS-010 292 Fld. 5/4

SAFETY CARS: THE ORIGIN OF THE SPECIES

by Karl Ludvigsen

Published in *Motor Trend* v23 n5 p37-8, 40 (May 1971)

Proposed designs for modern safety cars date back to the mid-50's. In 1957, an insurance company financed a body mockup with folding doors and centrally-placed driver. Improved, operating versions (known as Survival Car II) had a protective capsule-chair seat. In the mid-60's, two Italian safety car prototypes were built, and New York State awarded a contract to Republic Aviation to build and test a design. The Federal program for full-size safety cars began slowly; prototypes from two non-automotive company contractors are due in late 1971 and a self-financed design from an automotive company a year later. Under agreements with the German and Japanese transport ministries, experimental safety vehicles in the 2,000-pound class may be ready for tests in 1973.

Search terms: Safety cars; Experimental automobiles; Safety research; Crashworthiness; Automobile design; History; Automobile costs

HS-010 293 Fld. 5/4

A STUDY OF IMPACT BEHAVIOUR THROUGH THE USE OF GEOMETRICALLY SIMILAR MODELS

by G. W. Barley; B. Mills

[1971] 22p 10 refs

The behavior of motor vehicles in frontal impacts has been investigated through the use of geometrically similar models; a small scale barrier collision test facility has been designed and built for the investigation. A large number of thin walled cylinders of various diameters, lengths, and wall thicknesses have been tested to establish scaling criteria. It was considered that models could be usefully employed in investigating crash behavior and in predicting full size vehicle behavior, and could lead to improvements in body design.

Search terms: Impact tests; Laboratory tests; Scale models; Barrier collision tests; Simulation models; Mathematical analysis; Front end collisions; Body design; Cylinders; Impact fords

HS-010 294 Fld. 5/4

EXPERIMENTAL VERIFICATION OF SURFACE VEHICLE DYNAMICS

by B. D. Van Deusen; J. M. Sneyd

Chrysler Corp.

1969 1v
Report no. NASA-CR-1399

Under a previous contract, a technique was developed which allowed prediction of the dynamic response of vehicles traversing yielding and non-yielding rough surfaces. Virgin terrestrial and extraterrestrial surfaces were classified according to their frequency and amplitude distribution. A single parameter was defined which allowed accurate estimates of surface roughness. This classification determined the nature of a random input to an analog computer simulation of the vehicle and surface dynamic models. In addition, deterministic inputs were used, and a simplified linear model technique was presented using transfer function concepts. The present study is the experimental verification of the above theoretical prediction techniques.

Search terms: Vehicle dynamics; Vehicle road interface; Surface roughness; Vehicle soil interface; Computerized simulation; Surface dynamics; Dynamic tests; Field tests; Dynamic models

HS-010 295 Fld. 5/4

FIBERBOARD IN THE AUTOMOBILE

by Frederick H. Lieb; John B. McCallum

Chrysler Corp.; Ford Motor Co.

1971 33p
Report no. SAE-710051

Presented at Automotive Engineering Congress, Detroit, 11-15 Jan 1971.

This paper presents a brief description of each of the main types of fiberboard used in the automobile. It covers typical applications for fiberboards with detailed information only on the interior trim parts. Applications where fiberboard and plastics compete are discussed. Also included are the advantages and disadvantages of fiberboards. The effect of humidity changes on fiberboard resulting in dimensional changes and warping tendencies in the fiberboard are explained, with illustrations which emphasize the need for proper fastening of fiberboard and a method of measuring warpage. Test methods, performance testing, and possible future applications are discussed.

Search terms: Fiberboard; Automobile interior design; Passenger compartments; Automobile materials; Polypropylene; Warpage; Physical properties; Performance tests; Inter-layer materials

AVAILABILITY: SAE

HS-010 296 Fld. 5/4

A HISTORY OF HEADLINING

by Julie Auerbach

Chrysler Corp.

5/4 Design (Cont'd.)

HS-010 296 (Cont'd.)

1971 10p

Report no. SAE-710066

Presented at Automotive Engineering Congress, Detroit, 11-15 Jan 1971.

This paper describes the history of the design and method of installation of cut-and-sew headlining and how it is affected by the design of the body beginning with the all-wooden construction of the first Chrysler up to the present day design. Construction of the headlining listing seam, the drafting procedure for determining their location and trim off around the window and door openings is described.

Search terms: Headliners; Upholstery; Fabrics; History; Automobile interior design; Automobile manufacturing; Padding; Body design

AVAILABILITY: SAE

HS-010 297 Fld. 5/4

THE CHEMICAL INDUSTRY'S ROLE IN AUTOMOTIVE SAFETY

by W. E. F. Rupprecht; M. E. Winquist

Dow Chemical Co.

1970 6p

Report no. SAE-710644

Presented at Joint Meeting of SAE Mid-Michigan Section and American Chemical Society Midland Section, Midland, Mich. 24 Oct 1970.

The human factor will always be a deterrent to achievement of 100% safety in automobiles, but new design and materials have considerably narrowed the margin of risk in highway accidents. This article considers the contributions made by the chemical industry in providing materials suitable for this purpose. Improvements in crash padding, hydraulic fluids, and gas tanks have greatly reduced injuries attributable to impact, fire, and brake failure. Recent

developments are discussed. The close cooperation of the automotive and chemical industries is duly credited for these safety efforts.

Search terms: Chemistry; Crash-worthy fuel tanks; Plastic fuel tanks; Fire prevention; Occupant protection; Impact protection; Plastic foams; Padding; Brake fluids; History; Automobile interior design; Impact attenuation; Energy absorption; Vehicle safety

AVAILABILITY: SAE

HS-010 298 Fld. 5/4; 4/7

STRUCTURAL ANALYSIS OF FRAMES

by R. Ali; J. L. Hedges; B. Mills

Published in *Automobile Engineer* 376-9 (Sep 1970)

4 refs

By using finite element techniques, theoretical figures that approximate closely to measured deflections of a chassis frame can be obtained. Application of this method to static and dynamic analysis of chassis frames is a powerful tool for the analysis of designs in the initial stages. A computer program was developed to predict nodal displacements under various systems of static loading and natural frequencies and associated mode shapes of the structure.

Search terms: Chassis design; Dynamic structural analysis; Computer programs; Mathematical models; Static tests; Structural analysis; Frame design; Finite element method; Deflection

HS-010 299 Fld. 5/4; 5/14

THE SAFETY CARS ARE COMING

by A. B. Shuman

Published in *Motor Trend* v23 n5 p32-6 (May 1971)

Experimental safety car prototypes are nearing completion with in-built safety design far in advance of any production automobiles. Similar in size and weight to standard large American sedans, they are designed to be superior in avoiding accidents, withstanding crashes and protecting occupants, minimizing injuries to pedestrians, providing for escape and for various emergencies. Both designs will have antiskid brakes, air bag restraints, periscopic rear mirrors, fire protection and prevention. After the cars are crash tested in spring of 1972, 12 more of improved design will be built for further research and testing, ultimately to lead to safer production automobiles.

Search terms: Safety cars; Experimental automobiles; Crashworthiness; Impact protection; Air bag restraint systems; Safety programs; Vehicle safety standards; Vehicle design; Vehicle handling; Federal role; Periscopic rearview mirrors; Antiskid brakes; Fire prevention

5/6 Fuel Systems

HS-010 300 Fld. 5/6

THE DUAL-FUEL VEHICLE PROJECT

by Robert M. O'Mahoney

General Services Admin.

1970 7p

GSA's program had its beginning last July when Administrator Kunzig directed an investigation of the dual-fuel vehicle system. Mr. Kunzig's interest in the system was sparked by the fact that most of the 325,000 vehicles operated by the civilian and military agencies of the Federal Government were purchased through the General Services Administration. The investigation of the system led to the dual-fuel tests underway at one of our most smog plagued cities - Los Angeles. After analysis of the dual-fuel

system it was decided to launch a test of the system on government vehicles. The nature of the VA motor pool operation also involves a great deal of stop and go driving, giving GSA an opportunity to evaluate the use of compressed natural gas under the most difficult and pollution-producing driving conditions.

Search terms: Dual fuel vehicles; Compressed natural gas; Natural gas automobiles; Exhaust emission control; Air pollution control; General Services Administration

HS-010 301 Fld. 5/6

COMBUSTION ENGINE EMISSIONS

by Naeim A. Henein; Donald J. Patterson

Michigan Univ.

1970 1v 29 refs
Report no. 7041

Course notes from the Engineering Summer Conferences, Michigan Univ., 17-21 Aug 1970.

This text covers in general the automobile emission problem. Contents include HC and CO problems and their health significance; role of automobile in photochemical smog; chemical aspects of smog and the NO_x controversy; geographical and meteorological aspects of pollution; principles of gasoline engine operation; fuels for ICE's; effect of compression ratio, fuel-air ratio, and ignition timing on engine performance; carburetion; exhaust emissions; evaporative emissions; effect of design and operating variables on emissions; instrumentation and emission testing; and present and future emission control systems for gasoline engines.

Search terms: Air pollution emission factors; Smog; Air pollution control; Compression ratio; Emission control; Evaporative emissions; Ignition timing; Engine performance; Emission tests; Carburetors; Air fuel ratio; Internal combustion engines; Engine operating

conditions; Fuels; Exhaust emissions; Hydrocarbons; Carbon monoxide; Nitrogen oxides; Vehicle air pollution; Air pollution effect on health

HS-010 302 Fld. 5/6

WHERE ARE ALL THOSE GADGETS GOING?

by C. M. Heinen

Chrysler Corp.

1971 12p 15 refs
Report no. SAE-710074

Presented at Automotive Engineering Congress; Detroit, 11-15 Jan 1971.

With the passage of the Federal Clean Air Act, the automotive industry has a clear assignment to reduce automobile emissions drastically by 1975. The control devices presently available have already reduced hydrocarbons 83%, carbon monoxide 70%, and nitrogen oxides 33%. By 1975, these figures must be 98%, 97%, and 90%, respectively. Devices that have been developed to accomplish the reductions to date are discussed, and it is concluded that in the future, crankcase controls will require little change, evaporative controls some improvement, and engine modifications a great deal of supplementation to meet the 1975 standards. The two methods available which may permit meeting the 1975 standards are use of manifold reactors and use of catalysts. However, both present problems of materials and thermodynamics, due to high exhaust temperatures.

Search terms: Air pollution control; Emission control; Carbon monoxide; Hydrocarbons; Nitrogen oxides; Evaporative emission control; Crankcase emissions control; Exhaust emission control; Exhaust emission control devices; Exhaust manifold reactors; Engine modification; Vehicle air pollution

AVAILABILITY: SAE

HS-010 303 Fld. 5/6

EFFECT OF FUEL ADDITIVES ON THE CHEMICAL AND PHYSICAL CHARACTERISTICS OF PARTICULATE EMISSIONS IN AUTOMOTIVE EXHAUST. INTERIM REPORT

by John B. Moran; Otto J. Manary

Dow Chemical Co.

1970 86p 2 refs
Contract CPA-22-69-145
Report no. PB-196 783

Methods were developed for generating, collecting, and analyzing particulates in automotive engine exhaust by a means sufficiently accurate and reproducible to allow determination of the effects of fuel additives on exhaust particulate size, concentration, and composition. An air dilution chamber was designed which allows for cooling, dilution, and mixing so that representative particulate samples can be obtained at a sampling station which is essentially equivalent to 8-10 feet downstream of the end of the exhaust pipe on a vehicle at highway speeds. Diluted exhaust temperature is around 110 degrees F. Special analysis techniques were developed for the analysis and characterization of exhaust particulates. The data suggest a very significant effect of fuel additives, primarily tetraethyl lead, on the exhaust particulate size, concentration, and composition. Significant differences are observed with minor changes in other fuel additives.

Search terms: Spectral analysis; Particulate air pollutants; Particle size; Particle size analysis; Measuring instruments; Exhaust emission tests; Exhaust composition; Exhaust emissions measurement; Exhaust emissions sampling; Hydrocarbons; X-ray diffraction; Fluorescence; Fuel additives; Tetraethyl lead; Nitrogen oxides; Engine deposits; Fuel mixtures; Engine operating conditions; Microscopes; Mass spectroscopy; Ultraviolet analyzers

AVAILABILITY: NTIS

HS-010 304 Fld. 5/6; 1/3

A STUDY OF THE RELATIONSHIP OF STREET LEVEL CARBON MONOXIDE CONCENTRATIONS TO TRAFFIC ACCIDENTS

by George D. Clayton; Warren A. Cook; W. G. Fredrick

Published in *American Industrial Hygiene Association Journal* v21 n1 p46-54 (Feb 1960)

2 refs

Grant PHS-RG-5005 (C)

Presented at the 20th annual meeting of the American Industrial Hygiene Association, Chicago, April 1959.

Since disturbances of vision and reflexes could be factors influencing traffic accidents, a research project was begun to determine whether carbon monoxide as an atmospheric pollutant may have a sufficient effect on the individual driver in urban areas to exert a causal influence on automobile accidents. It was concluded that although more work needs to be done on the carboxyhemoglobin saturation required to affect sensory-motor performance, any CO-hemoglobin saturation less than 10% will not cause any disturbance in driving ability. Since only three persons out of 273 studied were in excess of this figure, the CO concentration in an urban area such as Detroit is not a factor in impairing driving ability.

Search terms: Air pollution effect on health; Carbon monoxide poisoning; Blood carbon monoxide levels; Carboxyhemoglobin; Carboxyhemoglobinemia; Accident factors; Mathematical models; Statistical analysis

5/10 Lighting Systems

HS-010 305 Fld. 5/10; 2/9

MEASURING THE BRIGHTNESS OF REFLECTIVE MATERIALS

by Thomas L. Harrington

Published in *Traffic Engineering* v4 n10 p19-24 (Jul 1971)

5 refs

Retro-reflective materials, which return light in the direction of origination over a wide angle, are widely used on signs, markers, delineators, license plates, and vehicle reflectors. Apparent brightness of a reflector depends on angles of the observer's eye and illuminating light, intensity of the illumination and sensitivity of the eye, spectral composition, (color) and projected area of reflector. A test method consisting of miniaturizing the actual viewing situation is outlined for measuring specific luminance of retro-reflectors.

Search terms: Reflectance; Reflective materials; Laboratory tests; Reflecting surfaces; Visibility; Brightness

HS-010 306 Fld. 5/10; 5/20

IMPROVING TRUCK LIGHTING

by Jack Steel

Published in *Fleet Owner* v66 n7 p73-7, 172 (Jul 1971)

Bulb failure is the cause of most of the trouble with trucks and trailer lights. The features of several heavy duty bulbs are described and discussed. It is concluded that better lamps and reflectors cost more to begin with, but result in much reduced maintenance.

Search terms: Lamp standards; Reflectors; Truck maintenance; Lamp failures; Service life

5/12 Manufacturers, Distributors, and Dealers

HS-010 307 Fld. 5/12

1971 AUTOMOBILE FACTS AND FIGURES

Automobile Manufacturers Association, Inc.

1971 74p

Statistics are presented on: motor vehicle factory output, exports, imports, world production trends, vehicle registration, scrapping, automotive materials, driver age and sex, automobile ownership, vehicle mileage and usage, miles of roads and streets, taxation, trucks, and fatality rates.

Search terms: Automobile production statistics; Transportation statistics; Vehicle registration; Automobile scrap statistics; Exports; Imports; Automotive industry; Trucks; Automotive parts; International factors; United States; Fatality rates; Taxation; Vehicle mileage; Automobile ownership; Automobile materials; Driver age; Driver sex; Canada; Automobile usage; Highway mileage

5/15 Propulsion Systems

HS-010 308 Fld. 5/15

ROLLS ROYCE-WANKEL DIESEL

by F. Feller; Phil Bloom

Published in *Automotive Design Engineering* v10 p47-9 (Feb 1971)

Extracted from *The Two-stage Rotary Engine—a New Concept in Diesel Power*.

Compactness and fuel economy were the main goals of an engine design suitable for military vehicles or large commercial vehicles. Obvious obstacles to running a Wankel engine on a diesel cycle were overcome by adding a second rotor operating both as compressor and expansion unit to produce a high compression ratio, low surface-to-volume ratio, and compact combustion chamber; and using direct injection to permit better sealing. A 500 cubic centimeter prototype yielded 50 hp and the present design allows for up to 1,000 hp with combined rotor banks.

Search terms: Wankel engines;

Rotary engines; Diesel engines; Hybrid engines; High powered engines; Engine design; Engine tests; Rolls Royce; Heavy duty vehicles; Apex seals

5/18 Steering Control System

HS-010 309 Fld. 5/18

PROBLEMS IN SUSPENSION DESIGN

by Guy Tidbury; Peter Chell; Ellis; Jo Wilson; Jack Channer; Jo Dreissiger; Alex Moulton; Reg Atkin

Published in *Automotive Design Engineering* v10 p16-7, 19, 21, 23-4 (Feb 1971)

Automotive designers and tire specialists considered the state of the art in suspension design. Conventional and advanced systems were discussed in relation to suspension medium, computer analysis and design, good handling, spectral density analysis, longer wheel travel for British cars, low profile radial tires, vehicle weight, steering compliance, and tire lateral compliance.

Search terms: Suspension systems; Spectral analysis; Vehicle stability; Vehicle handling; Automobile design; Computerized design; Radial tires; Tire forces; British vehicles; Vehicle weight; Steering; Lateral force; Automobile center of gravity

5/20 Trucks and Trailers

HS-010 310 Fld. 5/20

TOP FLEET EXEC DETAILS SAFETY RISKS, WAYS TO MINIMIZE THEM. HELP MAKE SPECS SHARPER, FLEET SAFETY MEN URGED

by Robert H. Shertz; Ed Shea

Published in *Commercial Car Journal* v121 n5 p52-4 (Jul 1971)

Two presentations before fleet safety executives are reported. Mr. Shertz discussed factors that add to safety problems in fleet operations, and suggested ways to minimize safety risks arising from them. These were: intensify driver training and defensive driving techniques, eliminate defects in equipment before accepting delivery, improve working conditions and communications to reduce driver turnover, improve driver attitudes, make grievance committees more safety conscious, consider safety more than payload when inspecting vehicles, investigate accidents promptly and completely, and cut insurance costs by reducing accident frequency. Mr. Shea stressed the importance of cooperation of safety departments with maintenance departments since their goals are tightly interwoven. He suggested the use of "safety equipment evaluation" forms to provide a flow of information between safety and maintenance managers, and also from the drivers to either or both. The importance of evaluation of drivers' complaints was emphasized.

Search terms: Fleet safety; Truck drivers; Trucking industry; Vehicle safety; Safety programs

5/22 Wheel Systems

HS-010 311 Fld. 5/22

SURVEY OF CORD CANDIDATES FOR RADIAL TIRE BELTS

by Zion S. Lee; Leonard Skolnik; Carl Z. Draves, Jr.

Published in *Rubber World* v164 n4 p41-7 (Jul 1971)

7 refs

Presented at Division of Rubber Chemistry, Chicago, Fall 1970.

The belt cord is subjected to strenuous operating conditions in radial tires; it restricts tire crown movement circumferentially and laterally, and it reinforces the crown against bruises and punctures.

Important cord properties are tensile strength, modulus, stability against water and chemicals, heat resistance, brittleness, flex fatigue, power loss index, dimensional stability, and adhesion. The properties of seven kinds of belt cord materials are described: nylon monofil, polyester macrofil, rayon, glass, vinyl (polyvinylalcohol fiber), DuPont's Fiber B, and steel wire.

Search terms: Radial tires; Nylon; Polyester; Rayon; Steel wire; Fiberglass; Stress strain characteristics; Tire cords; Tire cord tests; Tire materials; Laboratory tests; Tensile strength; Modulus of elasticity; Stability; Heat resistance; Flexibility

HS-010 312 Fld. 5/22

TIRES. THEIR SELECTION AND CARE. INFORMATION TO HELP YOU GET THE MAXIMUM SAFETY, WEAR AND PERFORMANCE FROM YOUR TIRES

by F. C. Brenner

National Bureau of Standards

1971 36p
Report no. NBS-CIS-2

Care involves: breakin for 50 miles below 60 mph; correct pressure; not mixing tire types; alignment and balancing; not overloading; rotation and replacement when worn; good driving habits. Selection is guided by four principles: strength for maximum loads, stability in cornering at your driving speeds, suitability for driving conditions, and choosing to fit your needs—not just price. Select the type—bias ply, belted bias, or radial—to fit your driving habits and conditions; then decide on size, profile, and load range.

Search terms: Tire characteristics; Tire performance; Tire cords; Tire inflation pressure; Tire loads; Tire maintenance; Tire selection; Tire safety; Tire wear; Bias belted tires; Radial tires; Tire balancing; Wheel alignment; Tire pairing; Tire rotation; Snow tires; Wet road conditions

AVAILABILITY: GPO \$0.65

NHTSA DOCUMENTS

NHTSA Contractors Reports

HS-800 529 Fld. 5/10; 5/9; 3/12

VEHICLE FORWARD LIGHTING PERFORMANCE AND INSPECTION REQUIREMENTS. FINAL REPORT

by R. W. Hull; R. H. Hemion; D. G. Cadena; B. C. Dial

Southwest Res. Inst.

1971 129p 156 refs
Contract FH-11-7342
Report no. AR-814

Report for 26 Jun 1969-25 Jul 1971.

This project was instituted to study means of improving seeing distance in night driving. Objectives were to determine headlamp systems performance requirements, develop procedures for compliance testing and field inspection, and make recommendations for updating Federal Motor Vehicle Safety Standard 108 covering vehicle lighting. Experimental testing was conducted using new and present standard headlight systems to determine comparative glare and target detection distances. A three-beam system was developed for short term improvement and a polarized system as an optimum solution. The need for speed-sensitive, variable-intensity lighting was investigated. Commercial headlamp-aiming equipment was evaluated and effects on aiming of vehicle load and other variables studied.

Search terms: Loads (forces); Headlamp aiming; Photometry; Headlamp standards; Night driving; Polarized headlamps; Vehicle lighting; Glare tolerances; Headlamp brightness; Headlamp design; Speed; Headlamp leveling; Night visibility; Vehicle inspection; Sight distances; Headlamp tests; Headlamp glare; Safety standards compliance

AVAILABILITY: NTIS

HS-800 534 Fld. 5/5

DOOR CRASHWORTHINESS CRITERIA. FINAL REPORT

by R. L. Stalnaker; J. H. McElhaney; R. G. Snyder; V. L. Roberts

Michigan Univ. Hwy. Safety Res. Inst.

1971 190p 312 refs
Contract FH-11-7288
Report no. HSRI-71-104

Report for 21 Jun 1969-20 Jun 1971.

A series of side impacts to the head and body were conducted up to the lethal level with infra-human primates whose anatomical and physiological relationships are most like man. The mechanical responses were then correlated with the degree of injury determined by gross autopsy. Dimensional analysis techniques and extrapolation were made from the infra-human primate data to estimate human tolerance for side impact. The threshold of brain injury was determined from these scaling relations to be 56 G's peak acceleration with a triangular pulse of 7.5 milliseconds. A tolerable contact pressure of 19 psi was established when impacted in the side by an arm rest-like striker. Both computerized simulations and sled tests were used.

Search terms: Doors; Impact tests; Door system failures; Animal experiments; Animal impact tolerances; Head impact tolerances; Human body impact tolerances; Side impact collisions; Side structure caused injuries; Mathematical models; Computerized simulation; Door design; Brain injuries; Impact sleds; Door caused injuries; Crashworthy bodies; Primates; Autopsies; Dimensional analysis

AVAILABILITY: NTIS

HS-800 546 Fld. 1/3

ACQUISITION OF INFORMATION ON EXPOSURE AND ON NON-FATAL CRASHES. VOL.

6-ACCIDENT RATE ANALYSIS. SUPPLEMENTARY FINAL REPORT

by P. S. Carroll

Michigan Univ. Hwy. Safety Res. Inst.

1971 40p
Contract FH-11-7293
Report no. 03169-6

Report for Mar-Jul 1971.

A group accident-rate difference method is introduced as a means of identifying driver-vehicle-road-environment classes which have unique accident rates. The recommended variables are now driver sex, driver age, vehicle type, model year, road type, day/night, and vehicle make. The new hierarchy contains only 18 driver-vehicle-road-environment classes, compared to the previous 26 classes. Among data bases for accident-rate calculations, mass state accident records are recommended as more accurate than individual records or survey subjects' recalled accident involvements. A single, comprehensive survey should be used in calculating group accident rate.

Search terms: Accident factors; Statistical analysis; Accident rates; Accident records; Environmental factors; Driver characteristics; Driver vehicle road interfaces; Variables; Accident risk forecasting; Driver sex; Driver age; Vehicle characteristics; Highway characteristics; Day vs. night accident risks; Accidents by vehicle make; Automobile models

AVAILABILITY: NTIS

HS-800 547 Fld. 5/4

DEVELOPMENT OF AN AUTOMOTIVE CRASH RECORDER. FINAL REPORT

by P. S. Klasky

Teledyne Goetech

DECEMBER 17, 1971

NHTSA DOCUMENTS

1970 125p 1 ref
Contract FH-11-7296
Report no. TR-70-37

This report covers the design and development of a recording accelerometer as an automotive crash recorder. The prototype recorder specifications, test data, and performance are described. Reliable, statistically valid data from actual traffic accidents are not available. Such data can be obtained only by installing crash recorders in many vehicles and providing an operational system for data processing and compilation. Such a recorder must be reliable, crashworthy, accurate, inexpensive, and easy to maintain. A crash recorder is described, consisting of four elements: a brushless DC motor, a magnetic disk, two accelerometers, and a capacitor which serves as a reserve power source for the motor.

Search terms: Recorders; Crash phase; Accelerometers; Direct current motors; Data processing; Accident records

AVAILABILITY: NTIS

HS-800 548 Fld. 5/4; 4/7

BASIC RESEARCH IN AUTOMOBILE CRASHWORTHINESS—ADDITIONAL EVALUATION OF THE ENGINE DEFLECTION CONCEPT. FINAL REPORT

by Patrick M. Miller; James E. Greene; Paul M. Culkowski

Cornell Aeronautical Lab., Inc.

1971 200p 8 refs
Contract FH-11-6918
Report no. YB-2684-V-7

Two vehicles incorporating the engine deflection concept were developed and impacted at speeds near 60 mph into a rigid pole barrier. Results measured from these tests were compared with those obtained from a similar test on a production (unmodified) vehicle. The structural responses of the modified vehicles gene-

rally demonstrate measurable improvement over those of the unmodified vehicle. A simplified analytical model was used to estimate the effects that various vehicle modifications would have on the passenger compartment responses. Similar structural changes were incorporated into a modified vehicle. Although test data were not recorded after 0.043 sec., similar trends were exhibited between the analytical model predictions and the experimental results up to the time of the data interruption.

Search terms: Engine deflection; Crashworthiness; Occupant protection; Deceleration; Barrier collision tests; Mathematical models; Computerized simulation; Energy absorbing front structures; Pole impact tests; Safety design; Engine modification; Passenger compartments; Crashworthy bodies; Acceleration; Displacement

AVAILABILITY: NTIS

HS-800 552 Fld. 1/3

NEW MEXICO ACCIDENT STUDY PROGRAM. FINAL REPORT 2

New Mexico Univ.

1971 210p
Contract FH-11-7216

Report for 1 Oct 1970—31 Jul 1971.

This final report is an analysis of thirty selected traffic accidents which were reported during the first contract extension period. The analysis included human, vehicle, and environmental factors which were related to accident causation and severity. The report also includes a description of operations, personnel, organization, and activities during the contract period as well as conclusions and recommendations which were drawn from the data obtained.

Search terms: Accident investigation; Case reports; Accident studies; Multidisciplinary teams; Accident analysis; Accident causes; Accident severity;

Environmental factors; Human factors; Driver vehicle road interfaces; Driver characteristics; Accident factors

AVAILABILITY: NTIS

HS-800 559 Fld. 5/21; 5/9

VEHICLE-IN-USE SAFETY STANDARDS STUDY. SUMMARY FINAL REPORT

by Fisher; Ediemiller; Biche

Ultrasystems, Inc.

1971 30p
Contract FH-11-7525
Report no. US-81202-2-Summ

Report for Jun 1970—Aug 1971.

The study compared the in-use condition of automobiles in periodic motor vehicle inspection (PMVI) areas (Pennsylvania, New Jersey, and Washington, D.C.) with that of automobiles in California, a random motor vehicle inspection state (RMVI). Considerable effort was expended to minimize variances in the data collected from diagnostic centers used and to develop standard component test criteria. Vehicles in the PMVI areas were in significantly better condition. This summary volume briefly presents the study and tabulates results.

Search terms: Vehicle inspection; Vehicle safety; Vehicle safety standards; Diagnostic centers; Computerized safety research techniques; Used automobiles; Defects; Vehicle sampling

AVAILABILITY: NTIS

HS-800 560 Fld. 5/21; 5/9

VEHICLE-IN-USE SAFETY STANDARDS STUDY. FINAL REPORT

by Fisher; Eidemiller; Biche

Ultrasystems, Inc.

**NHTSA Contractors Reports
(Cont'd.)****HS-800 560 (Cont'd.)**

1971 413p 15 refs
Contract FH-11-7525
Report no. US-81202-2-FR

Report for Jun 1970–Aug 1971.

The study compared the in-use condition of automobiles in periodic motor vehicle inspection (PMVI) areas (Pennsylvania, New Jersey, and Washington, D.C.) with that of automobiles in California, a random motor vehicle inspection state (RMVI). Considerable effort was expended to minimize variances in the data collected from diagnostic centers used and to develop standard component test criteria. Vehicles in the PMVI areas were in significantly better conditions. This technical volume presents details of the experimental design, data collection, data analysis, data bank organization, and computer program.

Search terms: Used automobiles; Vehicle inspection; Vehicle safety; Vehicle safety standards; Diagnostic centers; Computerized safety research techniques; Data acquisition; Data processing; Inspection procedures; Reviews; Vehicle sampling; Vehicle age; Pennsylvania; New Jersey; District of Columbia; California; Automobile models; Vehicle mileage; Regression analysis; Variables; Parameters

AVAILABILITY: NTIS

HS-800 573 Fld. 4/7; 3/2**MATHEMATICAL SIMULATION
OF DAISY TRACK HUMAN VOL-
UNTEER TESTS. FINAL REPORT**

by D. H. Robbins; R. G. Snyder; V. L. Roberts

Michigan Univ. Hwy. Safety Res. Inst.

1971 63p 6 refs
Contract FH-11-6962
Report no. HSRI-Bio-M-71-6

Report for Aug 1969–Dec 1970.

A study has been conducted as an initial step in determining the differences observed between the motions of a living human impact sled test subject and a dummy test subject. The mechanism proposed for accomplishing this is the HSRI two-dimensional mathematical crash victim simulator. A series of measurements were taken on human test subjects including classical and non-classical anthropometric measurements, range of motion measurements for the joints, and maximum foot force measurements. A series of mathematical expression have been used to predict body segment weight, centers of gravity, and moments of inertia using the results of the various body measurements. Data for use with the mathematical model were then prepared. In addition to the body measurements, the deceleration profile for the Daisy sled was determined, and the geometry and force-deformation characteristics for the seat and restraint environment were determined. A computer simulation of an impact sled test involving a human volunteer was made.

Search terms: Computerized simulation; Human body simulation; Impact tests; Impact sleds; Impact forces; De-

celeration; Mathematical models; Anthropometric dummies; Restraint systems; Deformation; Human body center of gravity; Human body segment weight; Human body mass moment of inertia; Anthropometry; Test volunteers; Seats

AVAILABILITY: NTIS

HS-800 589 Fld. 1/1**CONSOLIDATED SYSTEM OF
EMERGENCY SERVICES
(PROJECT 20/20). FINAL RE-
PORT**

Nebraska Office of the Adjutant General

300p
Contract FH-11-6854

The project organized and operated a total system demonstration to evaluate improvements in accident notification, central aid dispatch, and vehicles and personnel which provide emergency services at the accident scene and en-route to the treatment center. Project elements were notification, video tape documentation, ambulance attendant training, computer assisted information system (dispatching), comparative analysis of air and ground ambulances, telemetry, and a demonstration classroom-laboratory. Benefits of the system are discussed.

Search terms: Emergency medical services; Demonstration projects; Communication systems; Ambulance personnel training; Helicopter ambulances; Telemetry; Benefit cost analysis; Nebraska; Emergency reporting systems

AVAILABILITY: NTIS



executive summary

A SYNOPSIS OF A RECENTLY RELEASED NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION RESEARCH REPORT

VEHICLE-IN-USE SYSTEM SAFETY ANALYSIS FINAL REPORT

The purpose of this research contract was to establish a program to improve the safety characteristics of passenger vehicles now in use; to perform a system safety analysis of the vehicle and its subsystems in order to identify potential and actual failure paths and modes, and establish the safety criticality of each; to utilize the results of the analysis as a partial basis for establishing the direction for continual research leading to more effective standards for vehicles-in-use, as well to establish research priorities.

Contract FH-11-7316
Booz-Allen Applied Research, Inc.
4733 Bethesda Avenue
Bethesda, Maryland 20014

Award Amount: \$218,000.00
Contract Research Period:
June 20, 1969 to July 1, 1970

There are six volumes to the report:

DOT/HS-800 385 Vol. I: Summary Report PB-197 301

DOT/HS-800 388 Vol. IV: Safety Analysis of Visibility
and Human Impairment PB-197 304

DOT/HS-800 386 Vol. II: Background and Overview PB-197 302

DOT/HS-800 389 Vol. V: Safety Analysis of Steering
System PB-197 305

DOT/HS-800 387 Vol. III: Safety Analysis of Braking
Systems PB-197 303

DOT/HS-800 390 Vol. VI: Safety Analysis of Power Management
System PB-197 306

Purpose and Scope Defined

The National Highway Traffic Safety Administration has the responsibility to reduce accident losses. Its continuing program toward this goal has divided the related problems according to time in crash sequence, such as the pre-crash, crash and post-crash and, the influencing factors such as the vehicle, human and, environmental.

This study is directed toward vehicle factors in the pre-crash phase which possess accident causation potential. Furthermore, vehicle accident countermeasures are considered primarily for vehicles-in-use

(used cars), although it is recognized that certain countermeasures evolving from the study could be applied to new cars.

The only mechanism available to NHTSA to implement vehicle accident countermeasures is to issue standards. Up to the time of completion of this study, 26 new car standards had been issued but none apply specifically to used cars. Such standards can take any of the following forms:

- (1) Motor Vehicle Inspection (MVI) Standards
- (2) Reliability Improvement Standards

(3) Repair and Maintenance Standards

(4) Performance Standards

The first would result in forced replacement of inadequate components at periodic intervals corresponding with the inspection interval. The second would require a greater design life for critical parts both in new vehicles and replacement parts. The third would attempt to ensure that repair and maintenance practices do not degrade inherent performance below a predetermined level. The fourth category, Performance Standards, could be issued both for new and used vehicles, which would in fact dictate certain vehicle or component design characteristics. An example of the latter is the redundancy standard (No. 105) imposed on vehicle braking systems which has led to the use of a dual brake master cylinder.

The study was initiated to perform a vehicle systems safety analysis with the following objectives:

- Primary Objective (Task 1) -- Perform a system safety analysis of the vehicle and its subsystems in order to identify potential and actual failure paths and modes, and establish the safety criticality of each. Utilize the results of the analysis as a partial basis for establishing the direction for continued research leading to more effective standards for vehicles in use as well as research priorities.
- Secondary Objective (Task 2) -- Determine the effects of existing and proposed Federal Safety Standards (including motor vehicle inspection) on the safety criticality of the various failure paths and modes determined in Task 1.
- Secondary Objective (Task 3) -- Evaluate the cost-benefit characteristics of motor vehicle inspection, reliability improvement, and vehicle design changes in reducing the safety criticality of the various individual motor vehicle systems or components.
- Criticality is defined as the product of probability of occurrence and potential accident effect. Thus, probability incidence data were required as well as a scale upon which to measure potential effects.

A detailed safety analysis was conducted using the "fault tree" technique evolved in recent years by the aerospace industry. Failure mode criticalities were

determined within the limits of available data, and specific recommendations were developed for standards or further research necessary for the detailed formulation of standards. Existing and proposed standards were reviewed in terms of their effect on failure modes and safety criticality. No detailed cost projections were attempted in comparing inspection, reliability improvement, and design changes for criticality reduction. The study showed in most cases that each highly critical fault appeared to be best handled by a specific approach and, this approach was the one recommended. Insufficient data were available for previous studies to provide for realistic estimates of the costs of implementing these recommended standards.

SUMMARY OF MAJOR CONCLUSIONS AND RECOMMENDATIONS

The rank ordered criticality lists have been reviewed and screened to determine:

- The most important areas for new standards development
- The most effective means of implementing these standards
- Recommendations for further research leading to standards and further data gathering efforts.

These conclusions and recommendations have been summarized in this synopsis.

1. Braking System

o Conclusions

- A. Braking system performance is critical to vehicle safety, especially the following parameters:
 - Simultaneity of application
 - Balance (left-right)
 - Proportioning (front-rear)
 - System degradation
 - Linearity of brake torque response to pedal input
 - Bald tires
 - Poor performance in these areas leads to

inadvertent steering commands (pulling to one side), inadequate stopping distance, or wheel lockup which can result in instability or loss of steering capability.

- B. Introduction of the master cylinder design to meet the requirements of Motor Vehicle Safety Standard 105 reduces the criticality of total loss of brakes but introduces new partial failure which have relatively high criticality.

Recommendations

- A. Inspection — Brake system visual inspection and performance testing, including tire tread depth, should be mandatory in any PMVI program. It would be desirable to perform such inspections on new cars before delivery and following brake overhaul work. An important checkpoint in the inspection would be a test of the wearing circuit indicating partial loss of the braking system.
- B. Design — The advantages and disadvantages of alternate braking system designs should be evaluated to determine whether greater braking safety and longer life can be achieved through other than conventional designs. The importance of brake pedal characteristics such as linearity of response in driver performance should be determined. In addition the criteria for at least a rear wheel antilock standard should be determined.

2. Steering System

o Conclusions

- A. Loss of power boost in power steering system is critical to vehicle safety.
- B. Shock absorber performance is safety critical as shown by this study (and a previous study — contract FH-11-6629), and no adequate means exist for testing shocks on a vehicle.
- C. Front end looseness (ball joints) is important to vehicle safety.
- D. The addition of a steering wheel locking device introduces a new and serious failure mode to vehicles in use which did not previously exist. From a safety standpoint this is extremely poor practice.

o Recommendations

- A. Power Steering Reserve — A standard should be issued requiring cars with power steering to maintain steering torque below some maximum figure for a short time following loss of the power unit through pump or belt failure. Such a design would be comparable to present power braking systems.
- B. Shock absorber performance evaluation research should be conducted seeking convenient means for evaluating shock absorber performance during motor vehicle inspection. Two alternate approaches which should be considered are a means for direct testing on the vehicle, and use of built-in test points or performance indicators.
- C. Ball Joint Design and Inspection — It is recommended that research be conducted to evaluate the relative safety merits of the four current ball joint mounting configurations and to determine which inspection methods can be most efficiently and effectively used.
- D. Steering Wheel Lock — Alternate means of vehicle protection should be considered which do not introduce safety critical failure modes. A safety analysis should be conducted of the various steering wheel lock designs to determine whether such devices should in fact be prohibited because of possible degradation and failure on older vehicles.

3. Power Management System

o Conclusions

- A. Vehicle acceleration capability is an important safety consideration in normal driving and accident avoidance maneuvers.
- B. The acceleration linkage assembly is safety critical and should have improved reliability. The value of the proposed standard for redundancy in accelerator control systems, presented in the Federal Register of October 3, 1969, is verified. However, because of the importance of this fault, a basic design change should be considered and is discussed below. Inspection of accelerator linkages should also be a mandatory requirement of any inspection program.

o Recommendations

- A. Acceleration Control System – It is recommended that research be conducted to determine the feasibility and practicability of a “fly-by-wire” system for acceleration control. This would entail an electrical, rather than a mechanical, link between the accelerator pedal and the carburetor.

It would eliminate the problems of mechanical binding and spring failures and would permit ready incorporation of operational redundancy and fail safe features.

- B. Engine Performance (acceleration characteristics) – It is recommended that an analysis be made of engine performance degradation rates under varying operating conditions to determine whether motor vehicle inspection or ignition system design reliability control can best maintain engine performance within safety limits. A reliability standard on ignition system performance might also substantially reduce owner maintenance costs. It would also be desirable to require minimum acceleration characteristics for new vehicles, and to inspect used cars against these standards. The limits would have to be determined based on an analysis primarily of the requirements for safety freeway ingress.

4. Human Impairment-Related Components

o Conclusions

- A. Carbon monoxide poisoning of vehicle occupants should receive special attention in vehicle inspection because of its high safety criticality.
- B. Fuel system integrity and exhaust system hot spots are safety critical because of their fire potential.

o Recommendations

- A. Safety Associated with Emission Controls – It is recommended that a safety analysis be performed of all aspects of current and proposed emission control methods. Special emphasis should be placed on hotter exhaust system components (as a potential fire source), rapid degradation of engine performance, and the potential fire hazards associated with fuel evaporative emission control methods, and the additional fuel and

fuel vapor lines associated with newer vehicles.

- B. Fuel and Exhaust System Inspection – It would be desirable for motor vehicle inspection programs to include inspection for carbon monoxide level in the closed passenger compartment, in addition to normal inspection of exhaust system integrity. Also the complete fuel system should be inspected for any leaks or worn hoses, and exhaust system components tested for excessive temperature (resulting from poor timing or worn/failed exhaust valves).

- C. Fuel Line Routing – It is recommended that a study be made of the safety implications of fuel line routing and design to determine if standards should be written to minimize the likelihood of fuel leaks under both normal operating and crash conditions.

5. Maintenance and Repair Practices

o Conclusions

Sufficient indication was found in the course of this study to indicate a need to review maintenance and repair practices on certain safety-critical systems including brakes, ignition and carburetion systems. Numerous critical faults can be introduced through poor maintenance practices.

o Recommendation

It is recommended that an evaluation be made of the potential safety problems created through the maintenance and repair process in safety-critical systems. Such a study should result in both design and inspection recommendations for reducing the magnitude of maintenance-induced errors.

6. Overall Motor Vehicle Inspection Standards

The total number of motor vehicle inspection points indicated to be high in the criticality ranking is summarized in Table 10 in the report. These points are compared with inspection criteria developed under two other NHTSA contracts and current inspection points used by the State of Massachusetts. A thorough review of this data should be made to aid in developing criteria for a national motor vehicle inspection program or, guidelines for state programs.

7. Alternative Means for Standards Implementation

For the standards areas discussed, a comparison has been made, in the report, of the alternate means of implementation which summarizes the standards, the maximum criticality associated with each, and a designation of the preferred implementation mechanism from among MVI, design and reliability standards.

It was also desired to compare the costs of these alternatives where more than one method was applicable. The following discussion indicates the cost categories which need be considered and the problems associated with estimating these costs.

New car standards can be written which require a redesign of certain vehicle components to achieve higher reliability or reduce the potential effect of a given failure. Such standards involve costs to the manufacturer for design and development, tooling, material, and assembly. The problems of estimating such costs without a detailed design were discussed in the report "Motor Vehicle Standards Cost Estimating" prepared under Contract FH-11-6914. (4 Vols.-DOT/HS-800 263 through DOT/HS-800 266).

A standard establishing a national motor vehicle inspection program would represent different costs to different states in establishing the program. States which currently do not have a Periodic Motor Vehicle Inspection (PMVI) program would incur the costs of establishing and monitoring the program structure and either building inspection facilities or licensing private sources to do so. These states would then go through a defect reduction period during which owner repair costs would be increased. States with existing inspection programs (or new states following the initial transient) would have to alter their inspection criteria with the attendant increased costs of inspection and owner repair costs.

Standards directed at replacement parts or repair and maintenance practices would result in certain unique costs. Higher replacement part reliability or quality would result in higher manufacturing and test costs. Standards on repair and maintenance practices could involve the general licensing of mechanics or enforced inspection of completed rework by licensed individuals. In either case, added labor costs would be incurred.

Comparison of the costs of alternate means of achieving component criticality reduction would require first clarification of the assumptions re-

garding the nature of the standard and the population to which it would be applied; and second the development of a comprehensive cost model which could yield valid estimates encompassing all of the major variables discussed.

8. New Vehicle Controls

o Conclusion

The addition of new controls to vehicles for a variety of purposes is introducing, in many cases, additional vehicle safety problems. Examples include: hidden headlights, automatic speed controls, steering wheel lock devices, and emission controls.

o Recommendations

A. It is recommended that procedures be established to ensure that any motor vehicle standards initiated for reasons other than safety, be thoroughly reviewed by NHTSA for potential safety implications.

B. It is recommended that explorations be initiated to determine the necessity for and desirability of providing some mechanism by which motor vehicle design innovations related to safety can be thoroughly assessed for their safety implications before the designs become frozen.

9. Recommendations for Additional Data Gathering

A. Fleet Data - It is recommended that efforts be made to obtain additional maintenance data on large vehicle fleets, and especially taxi fleets which offer greatly accelerated life test results. Such fleet data can provide greater insight into vehicle reliability problems and provide for a monitoring of safety critical systems in new car designs.

B. Defects or Performance Inadequacies as Accident Causation Factors - It is recommended that a detailed checklist be prepared for use by accident investigation teams to help them determine the contribution of vehicle defects and performance inadequacies to accidents. Such a checklist might increase the information gained from accident investigations and accelerate the slow and tedious process of establishing the direct link between vehicle factors and accident causation.

10. Vehicle Standards Initiated Outside DOT

It is recommended that procedures be established to ensure that any motor vehicle standards initiated outside of DOT for reasons other than safety be thoroughly reviewed by the National Highway Traffic Safety Administration for potential safety implications.

11. Vehicle Stability Criteria

It is recommended that analysis be performed to establish what basic vehicle design or performance criteria could be used as a basis for a fundamental passenger vehicle design standard which would guarantee some uniformity of desirable vehicle handling properties. Particularly, the limit performance under emergency braking conditions (with and without braking control) should be determined.

The Contract Technical Manager has certified that the contractor's work has been satisfactorily completed and that all contractual obligations have been met.

The opinions, findings, and conclusions expressed in this summary are those of the contractor and not necessarily those of the National Highway Traffic Safety Administration.

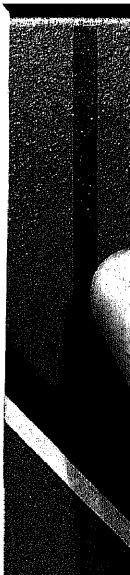
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